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Rural Energy Plan for North Tripura district

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Rural Energy Research and Extension
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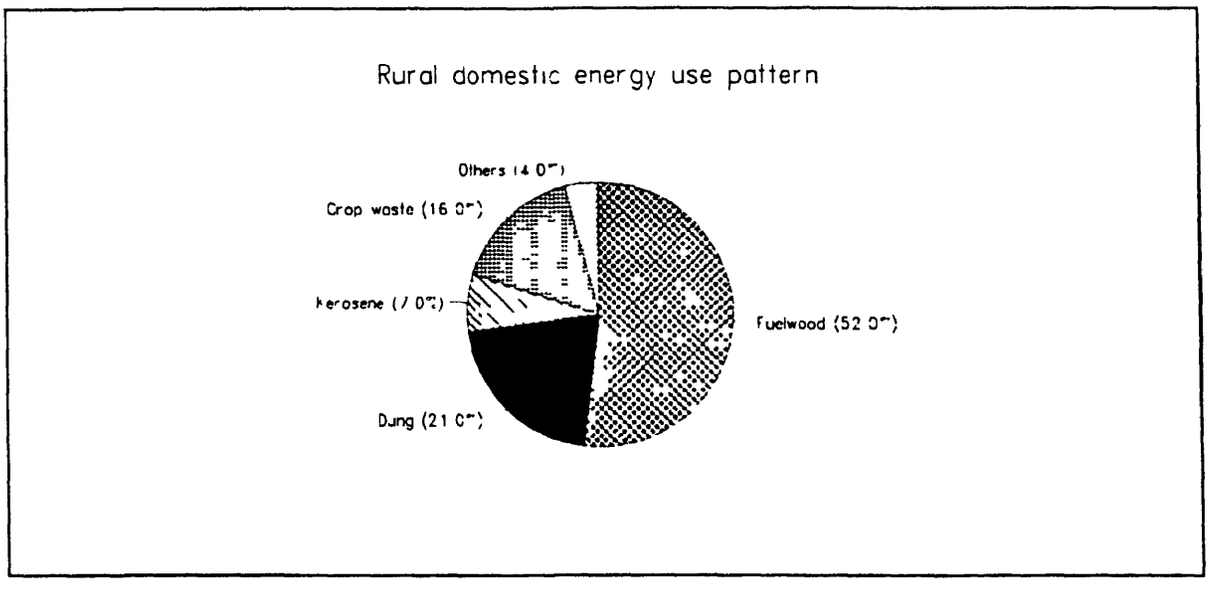
CHAPTER 1

Introduction

In spite of impressive growth in the availability of the commercial fuels in the last few decades, biomass sources still contribute 40% of the total energy in India Most of this energy is consumed in the rural areas, mainly in the domestic sector. Of the biomass fuels, firewood is the most prominent accounting for nearly 52% of the total energy in the rural domestic sector The main feature of the rural energy consumption pattern is that most of it is collected at 'zero private cost', and not purchased However, with increasing pressure due to commercial and agricultural demands on the forests and other types of lands which have been the traditional sources of biomass fuels, the rural energy consumption pattern based on biomass is becoming increasingly unsustainable in several parts of the country



This process is also evident in the North-eastern region, which is endowed with exceptionally rich natural resource base comprising large forest tracts, and vast deposits of petroleum and minerals The North-east, comprising seven states - Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura - and abounding in hills and valleys, is ethnically and culturally quite diverse within, and very distinct from the rest of the country. Hills constitute about 70% of the total land area in the North-east, where the logistical constraints hamper quick development of the region

Table 1.1. Forest resources in the North-east

State	Area (sq km)	Population (1991)	Dense forest (sq km)	Open forest (sq km)	Total forest (sq km)	Forest as % of total area	Per capita forest (ha)
Arunachal Pradesh	83743	858392	54542	14215	68757	82 1	8 0
Assam	78438	22294562	15842	8909	24751	31 6	0 1
Manipur	22327	1826714	5309	12376	17685	79 2	1 0
Meghalaya	22429	1760626	3305	12570	15875	70 8	0 9
Mizoram	21081	686217	4279	14574	18853	89 4	2 7
Nagaland	16579	1215573	3531	10790	14321	86 4	1 2
Tripura	10486	2744827	1825	3710	5535	52 8	0 2
Total	255083	31386911	88633	77144	165777	65 0	0 5

Source The State of Forest Report 1991, Forest Survey of India

As shown, considerably high proportion of the total area of North-east is still under forest cover, barring in Assam However, it has been a common observation that forests in the region have been depleting rapidly in the recent years, and this phenomenon is usually ascribed to shifting cultivation (*jhum*), a traditional practice still widely prevalent in the region. Industrial demand from outside for forest products such as timber, is another major reason for resource depletion; in fact, a substantial part of the timber needs of the country is met by the North-east The secondary damage done to the forest due to the falling trees during timber harvest, destroying vegetation in their path is also substantial Bamboo forests are being harvested in a major way by the paper and pulp industry

However, in spite of the unbridled exploitation of the forest resources, 65% of the total area is still under vegetative cover, with a per capita forest availability five times more than the national average (FSI 1991). But the extent of open forest (less than 40% crown density) has been increasing sharply indicating a high level of exploitation

As far as the energy consumption pattern of the region is concerned, more than 70% of the total energy is consumed in the domestic sector only, 90% of which is contributed by fuelwood alone (Ramana and Kukrety 1992). The role of other biomass fuels is marginal and animal dung is traditionally not used as fuel at all. Use of commercial fuels including electricity, kerosene and diesel is largely confined to towns whereas their accessibility to rural areas is limited due to their remoteness, and high infrastructural costs involved in reaching the fuels to these far-flung areas

Thus, fuelwood comes out to be the most important fuel in the region Much of the fuelwood consumed in the past used to come from secondary forests, with about 70% being from the peripheral distributed zone (Myres 1980), and only a small part from the primary forest However, increased population pressure and rapid depletion of primary forest cover in the region is fast changing the situation The population of the North-east had doubled in the first fifty years of this century, doubled again between 1951 and 1971, and a further 30% during 1975-85 (Ramana and Bhatty 1992)

Thus, the pressure on biomass fuels combined with limited reach of commercial fuels, has necessitated exploration of cost-effective renewable energy sources to meet the burgeoning energy demand Also, given the diversity that exists at the micro level in the region, it is imperative that energy supply options be developed as part of a decentralised rural energy plan, so as to utilise the natural resources in a rational and sustainable manner, and to sufficiently capture the specificities of the region It is in this context that the rural energy plan for the North Tripura district has been prepared

District energy planning

In the past one decade, the concept of decentralised rural energy planning has assumed significance with the promotion of area-based energy intervention programmes such as Integrated Rural Energy Planning Programme (IREP) - earlier implemented by the Planning Commission with block as the unit This programme has recently been shifted to the Ministry of Non-conventional Energy Sources (MNES) Alongwith this, MNES has also undertaken several energy planning exercises at the district level Wardha in Maharashtra, Mandla in Madhya Pradesh, Kutch in Gujarat, etc

In the context of the rural energy planning, district has been considered an appropriate unit as it is at that level most of the programmes are implemented from Financial allocations for different development programmes are usually released from the central and state governments to the district to be disbursed further Moreover, the necessary technical manpower and infrastructure required for energy planning and implementation are available at the district level Thus, rural energy planning at district level facilitates better integration of energy intervention programmes with the overall

developmental activity. However, the actual implementation of projects and programmes will have to be done at a lower geographical unit than district for logistical reasons. The experience provided by the district planning exercises sponsored by MNES suggests that the following strategy would yield the best results:

- *Energy plan* at the district level
- *Programme* denoting a group project for a cluster of villages at the block level, and
- *Project* at the village level

Such a decentralised approach will also facilitate incorporation of parameters specific to different ecosystems that are likely to exist within a district

Selection of District

North Tripura district in the state of Tripura was selected to represent the typical conditions that exist in the North-eastern region It has a composite topographical formation comprising high hills, small hillocks and also plains It is also a predominantly tribal district rich in biomass resources. Thus, the district was selected, in consultation with the officials of the government of Tripura and the North-Eastern Council

Objective

The basic objective of the decentralised rural energy planning exercise is ***to arrive at a feasible combination of energy interventions which are cost-effective and techno-economically viable, to meet the energy demand of a micro level unit*** (district, in this case) The basic elements of the planning exercise taken up in the North Tripura district are:

- Estimating energy demand,
- Assessment of energy supply system including the availability of biomass resources and commercial fuels;
- Formulation of an energy intervention plan for a fixed time period including design of an implementation strategy, and
- Integration of energy plan with the overall development planning process of the district.

Approach

The methodology adopted to execute each of these elements has been discussed below.

Secondary information collection

An extensive collection of secondary information was undertaken from a variety of sources at the block, district, divisional, state and national levels This information has been used to create a profile of the district to provide a broad understanding of the demographic, geographic and socio-economic aspects of the district which might have a direct or indirect influence on the energy system in the district For instance, the village level information on land-use pattern available from the District Census Handbook formed the basis for the selection of sample villages surveyed for primary data for assessing the biomass availability and estimating the energy demand Village level information on infrastructural facilities was used so as to identify different orders of settlements

Energy demand estimation

The incomplete quantitative understanding of the different components of the energy systems in rural areas would indicate that efforts be made to evolve a sample selection procedure that provides a greater insight into the rural energy system For energy demand, it is deemed desirable to select sample villages on three parametres 1) per capita forest land, 2) per capita agriculture land, and 3) order of settlement Of these, the first two parametres are assumed to reflect the stress and/or availability of biomass energy resources on which the energy system of North Tripura district is based Also, as the rural economy is based largely on agriculture, agricultural land would be a surrogate variable for income and purchasing power The level and number of infrastructural facilities also influence the energy mix higher the level of civic amenities, better is the accessibility and road network, which in turn leads to better access to higher efficiency fuels such as kerosene, diesel, LPG and electricity Therefore, an attempt has been made to identify different orders of settlements taking the level and number of infrastructrural facilities as a development indicator

A survey was designed to collect information for energy demand estimation, assessment of energy resources availability and formulating the implementation framework for possible interventions with specific reference to the district. Thus, while the main objective of the village survey was to estimate the energy demand for different enduses, the survey also aimed at:

- getting an idea of the local energy and development issues;
- getting an idea of the existing energy situation in different blocks, and
- finding the potential of different energy sources and their possible relevance for the development priorities of the district

Energy resource assessment

Study of the energy resources - commercial as well as non-commercial, was conducted to prepare an inventory of energy resources in order to assess the extent of their individual contribution to the present energy mix, and potential to meet the future demand.

Most of the energy needs are met from the biofuels, emphasis was given on getting a reliable estimate of the biomass resources available in the district For information on forest resources, extensive data collection and analysis from different records of the Forest Department such as working plans, annual administrative reports, etc was done. This information was then cross-checked with the consumption and supply data collected from the individual households during the primary survey

Assessment of energy supply dealt with two parts -- biomass resource assessment, and supply of commercial fuels Among the biomass resources considered were woody biomass, animal dung and crop residues and in the commercial sources, kerosene and electricity

Fuelwood is the principal fuel used in the district which is available from two sources -- forest lands under the control of the Forest Department, and non-forest lands in the villages (common lands, private lands, homesteads, etc)

One of the premises the woody biomass assessment exercise used was that in a predominantly-biomass district like North Tripura, most energy interventions to be suggested in the energy plan could be based on the biomass system This would have implications in terms of biomass availability Therefore, an attempt was made to estimate the quantity of growing stock and annual biomass production from the forests For this, extensive use was made of the records of the Forest Department such as Working Plans, annual administrative reports, etc

Estimation of dung availability was done using the block-wise cattle population figures available with the Veterinary Department in North Tripura Dung production has been estimated assuming an average production rate of 3 kg per cattle per day (based on the observations during the primary survey)

The yields of different non-fodder crops in North Tripura have been taken and using the standard straw-to-grain ratios for various crops available in the literature, the quantities of crop residues available in the district have been estimated

Kerosene is the main commercial fuel used in the district which is supplied through the Public Distribution System (PDS) Data for this was collected from the District Collectorate

Study of development priorities

Often in the past, development priorities of a particular region have not received adequate attention for which the energy planning exercise was being conducted, as a result of which the suggested energy interventions could not be properly integrated into the overall development strategy and thus failed to succeed One of the major shortcomings of the energy planning exercises done in the past was their inability to correlate the plans with overall development process (TERI 1992) For instance, if energy interventions were implemented in areas where energy was not perceived as a priority (in spite of the fact that it might be in shortage) by the people in that region, the programmes invariably led to non-success Another reason for the inadequate response to many development programmes could be traced to the divergence of perceptions between the people and the government officials of what the priorities of the region are This difference in the perceived priorities, is of relevance to the response of the people to energy related projects Thus, it is imperative to understand the development priorities of the region so as to place the energy requirements on the hierarchy of priorities This would have two advantages - firstly, it is easy to devise specific energy interventions that would go as direct inputs to development activities, and secondly, the chances of succeeding in implementation are high Therefore, it would be an integral part of the study in North Tripura to examine the development priorities, as perceived by the people as well the government which implements various development programmes in the district

For this purpose, a detailed analysis of various developmental activities was undertaken with the help of government documents which outline specific targets for programmes and budgetary allocations, etc On the other hand, detailed interviews with people during the primary survey were relied upon to document their perceptions

Energy planning

The existing energy consumption pattern, with predominance of woody biomass for thermal energy requirements, has indicated the importance of intervention in this sector. The estimate of energy demand presented in chapter 4, based on the exiting energy consumption in the district, underscored this. Based on the primary survey conducted in the district, it was observed that fuelwood has the major share of consumption in the domestic cooking sector. Due to abundant availability of fuelwood at a very low price in the I order settlement, and at 'zero private cost' in the II order settlement, fuelwood had a pre-eminent position in the domestic cooking sector One desirable intervention arising out of this finding has been to initiate measures for a more efficient use of woody biomass in the cooking sector. In the lighting sector, both kerosene and electricity are used to varying degrees in I as well as II orders of settlement The issue of providing quality lighting and electricity to remote villages have been taken up in this chapter in detail. Various technologies such as biogas, improved chulha, biomass gasifier, mini-micro hydel and solar photovoltaics have been considered as possible options

Setting targets

Most planning and implementation of energy programmes in India is based on targets stipulated by a level other, usually higher, than the level at which these targets are to be implemented. Among other consequences, this has resulted in an undue emphasis on the quantitative achievements of a programme rather than qualitatively fulfilling the objectives of a programme The need of targets for some degree of accountability cannot be disputed -- qualitative achievements, by definition, are difficult to measure and monitor and, therefore, undesirable from an administrator's perspective in spite of being easy to discern Despite these shortcomings, there appear to be no alternatives to setting targets for monitoring development programmes The procedure for setting these targets can, however, be modified so as to be more conducive to qualitative improvements in the intervention strategy The most obvious first step in this direction is training those who are to directly execute the programme in identifying suitable locations and beneficiaries Their concurrence in formulation of targets at the level at which the interventions are to be implemented will go a long way in ensuring effective implementation However, it is important in the process to have an overall perspective, or in the popular terminology, the local plan must "dovetail" with the national objectives. This process of decentralisation in formulating targets for implementation will contribute to the strengthening of the intervention process by relieving the higher levels of planning from decision-making regarding implementation. Regional priorities have to be formulated at a level higher than the district, with a similar consultation with

the districts Since the present study has focus on the formulation of intervention plan at the district level, the appropriate level for the targets would be a cluster of villages for which the desired interventions are to be implemented With this perspective, an attempt has been made to formulate the energy plan for North Tripura district

Management and implementation

Once the energy plan is prepared, the most crucial element is to devise a suitable implementation strategy including suggesting a management structure Proper management system, or lack of it, has been one of the major shortcomings in the implementation process of energy plans in the past Therefore, it is imperative that a management system be developed as an integral part of the energy planning exercise to ensure successful implementation of the energy plan For this, it is necessary to study the organisational functioning of different departments/agencies currently involved in the energy programmes so that suitable suggestions could be made For this purpose, the present organisational arrangements for implementing energy activities in North Tripura have been studied Based on this, an inter-organisational management system with reference to the energy interventions recommended in the plan has been suggested

CHAPTER 2

Profile of The District

Introduction

North Tripura is one of the three districts in the state of Tripura situated between 23°37'30" and 24°28'10" latitudes and 91°43'30" and 92°17'30" longitudes

The erstwhile Princely State of Tripura had merged with the Indian Union in 1949 as a part 'C' state and become a Union Territory on November 1, 1956 The Territorial Council was formed in 1959 and Legislative Assembly with a council of ministers in 1963 Tripura became a full-fledged state in January 1972 divided into three districts, namely, North, South and West The North Tripura district consists of five blocks (1) Kanchanpur (2) Panisagar (3) Chhamanu (4) Kumarghat, and (5) Salema. Kailasahar is the district headquarters The total geographical area of North Tripura district is 3544 sq km The district is bordered by Bangladesh on the west and north, Assam on the north-east, Mizoram on the east

Area and Population

North Tripura district has a total population of 636,326 as per 1991 census which is about one-fourth of the state population 91% of the population of North Tripura live in villages as against 85% in the entire state The district is sparsely populated compared to other districts with a density of 173 persons per sq km, as against 262 persons for the state Scheduled tribe population is 195,883 accounting for 30 78% of the total population and schedule caste population is 86,851 which accounts for 13 65%

Table 2.1 Area and population of North Tripura district

Block	Area (sq km)	Households	Population	SC	ST	Literates
Kanchanpur	1159 87	19723	104743	5765	61982	43654
Panisagar	440.3	31211	169328	18571	8283	90539
Chhamanu	838 44	16326	86948	7229	59361	30491
Kumarghat	502 00	25936	136372	21036	24239	64968
Salema	914 77	26370	138935	34250	42018	68238
Total	3855 38	119566	636326	86851	195883	297890

Growth rate of literacy has been impressive in the district since the last two decades, and by 1991, nearly 46.8% of the people were literate in the district.

In terms of occupational structure, there has not been much variation between 1981 and 1991. Agriculture remains the single most important occupation with two-third of the main workers being cultivators However, among the cultivators, very few people actually own the land while the rest are essentially sharecroppers. Most of the land in the district is owned by the tribals.

Physiography

The terrain of Tripura is dotted with small hillocks in the south-east and several hills in the northern and eastern sides which comprise 70% of the total geographical area. The agro-climatic zone in which the state falls is Eastern Himalayas (Planning Commission 1989). There are six principal hill ranges increasing in height from west to east Of these, *Jampai*, *Sakahan*, *Longtarai* and part of *Atharamura* fall within North Tripura district.

Physiographically, North Tripura district represents the typical 'ridge and valley' structural province and the topography is immature The major geomorphic elements are north-south running steep, narrow and parallel hill ranges, alternating with broad and flat valleys The principal hill ranges from east to west are *Jampai*, *Sukhan Tlang*, *Longtarai* and *Atharamura*, respectively The altitude of hill ranges increases progressively from west to east, the highest elevations being 975 m above MSL (mean sea level) at Bilianchip in the *Jampai* range, 316 m above MSL at Sakhan in the *Sakhan* range; and 481 m above MSL at Phengpur in the *Longtarai* range.

There are three broad longitudinal valleys, namely (i) Dharmanagar-Panisagar-Kanchanpur; (ii) Kailasahar-Kumarghat-Chhamanu and (iii) Kamalpur-Ambassa-Gandacherra valleys Within the major valley portions, there are numerous isolated hillocks attaining an elevation of 20-30 m above the valley floor which impart general undulation to an otherwise plain valley topography

There are long river valleys extending over a vast area in different sub-divisions formed mostly of deep, fertile alluvial deposits suitable for cultivation of paddy, jute, oil seeds, spices, fruits and vegetables

Soils

Soils of the district can be classified into two major groups on the basis of their origin residual soils and transported alluvial soils Due to high rainfall (2000-3000 mm per year) in the state, the soils and bed rocks are subjected to severe chemical weathering and rapid erosion. Overall, there are five categories of land (1) reddish yellow brown

sandy soils (2) loam and sandy loam soils (3) older alluvial soils (4) younger alluvial soils, and (5) lateritic soils The flat land of Tripura commonly known as *Lunga* is alluvial in nature consisting of sand, silt and clay Otherwise, the soil is lateritic with low water absorption capacity

The reddish yellow brown sandy soil is extensive on the north-south oriented hill ranges of the district, crowned with lush evergreen tropical forest Nearly 40% of the geographical area of the district is covered with this type of soil.

The red loam and sandy soils are also extensive, covering another 40% of the total area These soils are generally associated with numerous valleys and forest-covered undulating uplands of the district

The older alluvial soils are situated on the river terraces and high plains of the district Profiles of these soils are usually well developed Nearly 10% of the geographical area of the district is covered with this type of soil

The younger alluvial soils are mainly confined to the flood plains of the streams Dolai, Manu and Juri These soils usually comprise clay loams and loams These soils are affected by floods almost every year and are enriched by deposition of new layers of silt and clay The soils are, therefore, extremely fertile for agriculture capable of yielding assured harvest of rice and jute

Climate

The climate of the district is tropical in nature with distinct seasons of summer, monsoon and winter, and is characterized by moderate temperature and high humidity Winter season sets in November and lasts till the end of February, marked with pleasant days and cool nights The summer season starts from March and lasts up to May and is followed by south-west monsoon lasting till September The highest mean of maximum temperature recorded is 35°C and the lowest mean of minimum temperature recorded is 10 4°C

Rainfall

The district receives rainfall mainly from south-west monsoon, which commences in May and lasts till September The average annual rainfall over 30 years for North Tripura district is 249 cm The maximum rainfall is usually recorded during the months of June-July

The south-west monsoon lasts in Tripura from June to September, thunder showers usually occurring from about April to the break of the monsoon

Table 2.2. Rainfall pattern in North Tripura

Year	Average annual rainfall in the district (cm)	Average annual rainfall in the state (cm)
1984	257 4	269 4
1985	257.0	236.4
1986	222 8	253.3
1987	228.8	350.0
1988	325.3	332.0

Source: Directorate of Agriculture, 1985-86

River system

The major river system of North Tripura district comprises the rivers of Manu, Deo, Dhalai (Dolai) and Juri.

River Manu rises from the Kahoisib peak of the *Sakhan Tlang* Range and initially makes its course through various narrow gorges with escarpment of bare rock The river flows in a northerly direction till it by-passes Kailasahar town and enters Bangladesh The length of the river is about 167 km and has a catchment, including that of its tributary Deo, of 1979 sq km.

The Deo river, a 98 km tributary of Manu, originating from the *Jampai* hills, flows north-ward through the Kanchanpur valley and joins the Manu river near Kumarghat in the central part of the Kailasahar valley

The Dhalai river has its source in the *Longtharai* range near Dolajari peak It flows through Kamalpur valley between *Longtharai* and *Atharamura* ranges, and enters Bangladesh after Kamalpur town. It is 117 km in length and has 695 sq km of catchment area in the district

The Juri river has its source in *Jampai* hills It has a northerly flow through the Dharmanagar valley on the eastern side of the *Sakhan* range and has 586 sq km of catchment area in the district

Communications

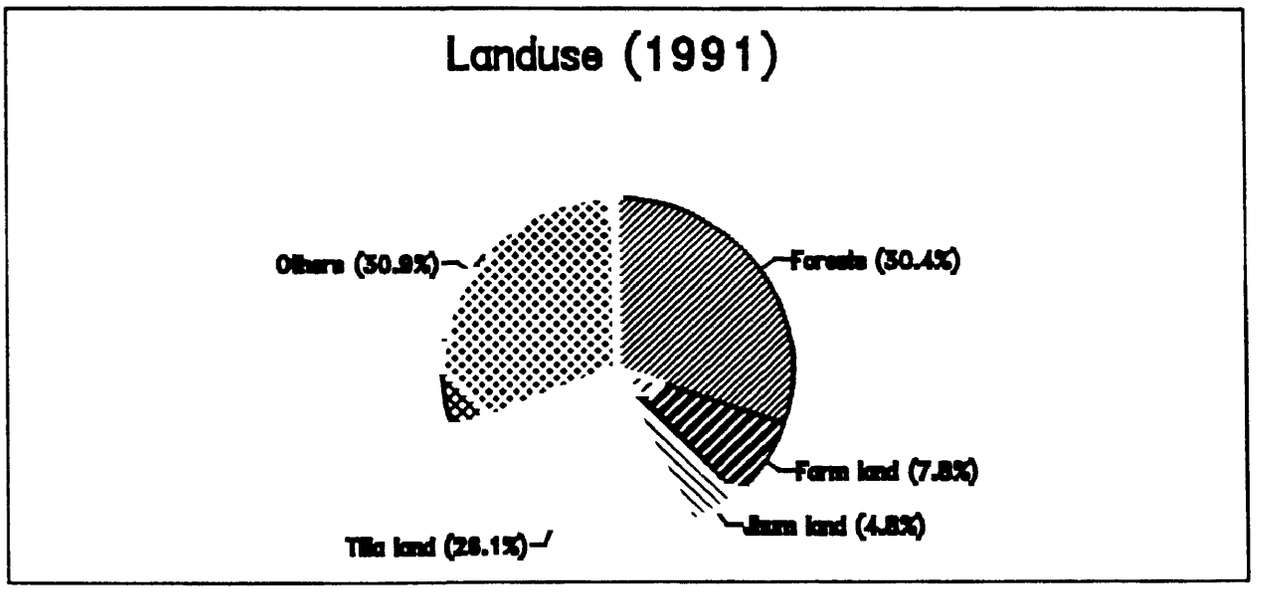
Kailasahar, the district headquarters, is well connected with other districts by all-weather metalled roads. National Highway No. 44 passes through the towns of Ambassa, Manu, Kumarghat, Panisagar, etc , and connects the district with Assam and the state capital, Agartala. The towns of Dharmanagar, Panisagar, Pecharthal, and Kumarghat are connected by rail with Assam

Land use and cropping pattern

At present, the total district area stands at 3544 sq km, of which forest is 30.4%, agricultural land 7.8%, land under shifting cultivation 4 8% and Tilla land 26 1%

Paddy is the most important crop grown in the district three times a year. Paddy is followed by jute, mesta, oil seed and sugarcane, etc In addition, orchards of cashewnuts and pineapples are raised over a limited area in the district. Rubber plantations are also being grown on small mounds and foothills Apart from paddy cultivation, a large number of farmers have been motivated to take up wheat as an additional crop mainly on lands which otherwise would have remained fallow in *rabi* season For production of pulses, a special drive has been launched as a second crop with the help of residual moisture on *tilla* land (small hillocks) where only one crop was raised earlier

Figure 2.1. Landuse



Crop yields are low in North Tripura district as compared to the state average The yield of rice is about 1548 kg per hectare as against 1646 kg per hectare for West Tripura district and 1735 kg per hectare for South Tripura district One reason for low yield in the district is that most of the land is under forest and hillocks. Other major reason is lack of irrigation facilities Though the district is endowed with numerous rivers and streams, agriculture is mostly dependent on rainfall

Another major reason for low yield of agriculture produce is little mechanisation, and the agriculture being mostly based on traditional implements Ploughing is mostly done through bullocks In the year 1987 there were 35,227 manually operated wooden ploughs in the district In the case of animal driven ploughs, North Tripura has the

lowest share i.e 829 as compared to West Tripura (6675) and South Tripura (1282) There were only two power tillers in the district.

Energy consumption

Domestic sector is the largest energy consuming sector with fuelwood being the most important source. Fuelwood is used for cooking, water heating and space heating and for construction of house and agricultural implements. Forest is the main resource in the district, from which the people collect fuelwood at 'zero private cost'

Kerosene is the major source of lighting in the district Supply of kerosene is hampered in the monsoon season due to frequent road blockades Spread of LPG is extremely low in the district, with the only distribution point situated at Kailasahar

The Department of Science, Technology and Environment (DSTE) is the nodal department responsible for the dissemination of renewable energy technologies in the district. Khadi and Village Industries Commission (KVIC) is also working in the district disseminating biogas plants A select list of solar and wind installations in the district is provided in table 2 3

Table 2.3 Select renewable energy installations in the district

S No	Name of villages	Capacity	Year	Technology	Purpose	Remarks
1	Khantlang (Jampai Hills)	2 88 kW	1991	Solar PV	Solar lighting in the village	Total village including BSF Camp
2	Kampui-II (Jampai Hills)	4.56 kW	1990	Solar PV	Solar lighting in the village	Total village including churches
3	Kampui-I (Jampai Hills)	2 88 kW	1990	Solar PV	Solar lighting in the village	Total village including churches
4	Kaishyram para	1 5 kW	1989-90	Solar PV	Solar lighting in the village	-
5	Phuldongsi (Reang colony) (Jampai Hills)	2 85 kW	1989	Solar PV	Solar lighting in the village	Total village including churches
6	Phuldongsi (Losai village) (Jampai Hills)	4 kW	1989-90	Solar PV	Solar lighting in the village	Total village including churches
7	Phuldongsi (Jampai Hills)	1 kW	1989-90	Wind and PV (generator)	For lighting and battery charging	-
8	Tukuine (Jampai Hills)	4 lights 1 TV	1989-90	Solar PV	For lighting	Solar light and TV in the churches
9	Sabual (Jampai Hills)	20 lights 1 TV	1987	Solar PV	For lighting	Lights in the churches
10	Tlangsang (Jampai Hills)	16 light points 1 TV	1987	Solar PV	For lighting	Lights in the churches
11	Banglabari (Jampai Hills)	12 light points	1986	Solar PV	For lighting	Lights in the churches
12	Mong chuang (Jampai Hills)	4 light points	1986	Solar PV	For lighting	Lights in the churches

S. No	Name of villages	Capacity	Year	Technology	Purpose	Remarks
13	Vaisam (Jampai Hills)	4 light points	1986	Solar PV	For lighting	Lights in the churches
14	Kachari Cham & Wimbook Cham	8 light points	1985-86	Solar PV	For lighting	Lights in the churches
	Dharmanagar sub division					
15	Halen Pur	8 light points	1988	Solar PV	For lighting	Lights in the churches
	Kanchanpur sub-division					
16	South Kangrai	12 light points 1 TV	1987-88	Solar PV	For lighting & streetlights	Lights in churches
	Kanchanpur sub-division					
17	North Kangrai	8 light points 1 TV	1987-88	Solar PV	For lighting	Lights in churches & streetlights
	Kanchanpur sub-division					
18	Tripura Dosde Kanchanpur	8 light points	1989-90	Solar PV	For lighting	Lights in boarding school & streetlights
19	Tachai Tea Estate	4 light points 1 TV	1987-88	Solar PV	Lighting & TV	Lights in the Tea estate
	Kailasahar sub-division					
20	a. Bhagasan tilla b. Kalai giri	8 light points 1 TV	1987-88	Solar PV	Lighting & TV	Domestic & Streetlights

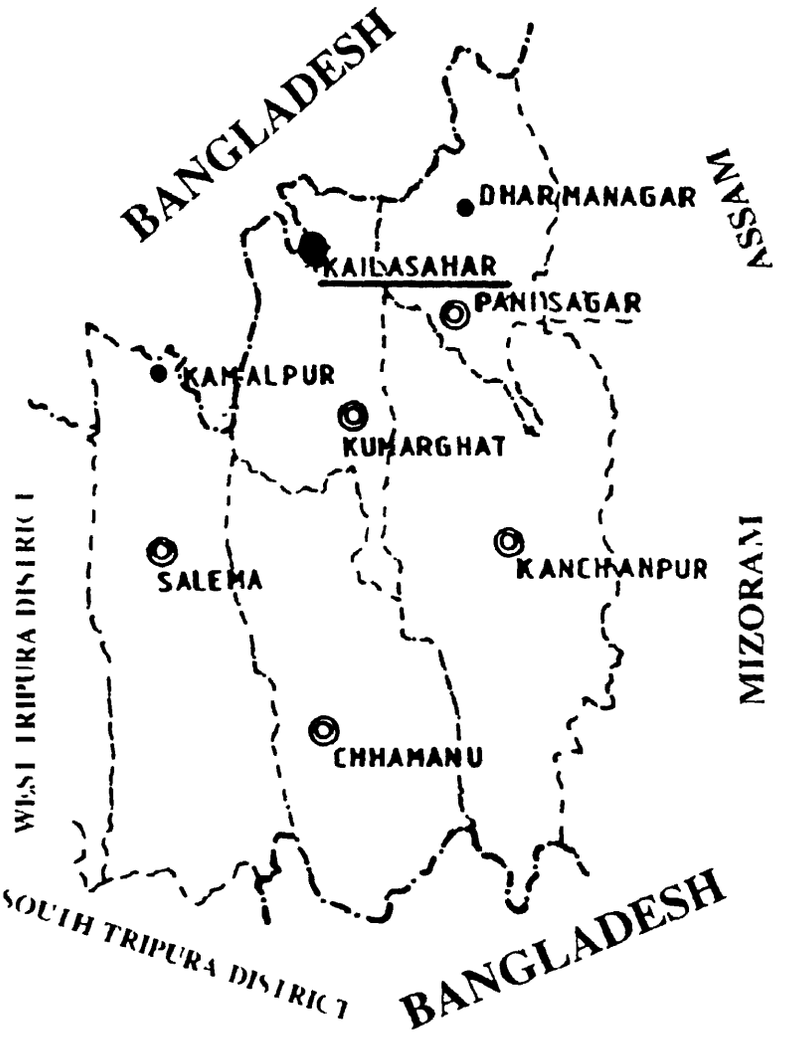
S No	Name of villages	Capacity	Year	Technology	Purpose	Remarks
	Kailasahar sub-division					
21	Ultachara	8 light points	1989-90	Solar PV	Lighting & TV	Lights in the boardings of school & streetlights
	Kailasahar sub-division					
22	Tailengban	8 light points 1 TV	1991-92	Solar PV	Lighting & TV	Lights in the churches & streetlights
	Kailasahar sub-division					
23	Kongthari Mandi	7 light points	1985-86	Solar PV	For lighting	Lights in the domestic, Mandir & streetlights
	Kamalpur sub-division					
24	Srinathpur	3 light points	1992	Solar PV	For lighting	Lights in the domestic, Mandir & streetlights
	Kailasahar sub-division					
25	Sib bari (Reang) South Unakuti Gao Sable	4 light points	1992	Solar PV	For lighting	Domestic & streetlights
	Kailasahar sub-division					
26	West Machli (Reang) Chamanu block	8 light points	1993	Solar PV	For lighting	8 community lights in the churches
	Kailasahar sub-division					
27	Katatille (Se) Kumarghat block	4 light points	1993	Solar PV	For lighting	Community lighting in the village

Note All the light points are 40W bulbs

As it is revealed from the above table, DSTE has installed solar photovoltaic systems for lighting in the areas which are remote and surrounded by dense forests. DSTE is also involved in dissemination of biogas plants, improved chulhas, roof run off tanks, etc in various parts of the district.

TRIPURA

NORTH TRIPURA DISTRICT



BLOCK HEAD QUARTER ◎

DISTRICT HEAD QUARTER ●

TOWNS •

CHAPTER 3

Energy supply

In an energy planning exercise, it is necessary to have an accurate estimate of the current energy supply from various sources meeting the demand of different energy enduses As is evident, the rural energy system is mostly dependent on the biomass resources and, thus, study of supply system is primarily a study of the biomass system in the district However, the pre-eminence of fuelwood among the biofuels notwithstanding, there have been few studies which made an attempt to estimate the availability of the resource - the consumption was often equated to the supply. In the present study, an attempt has been made to estimate the fuel supply coming from the forest In addition, supply situation of other major fuels has also been studied

Woody Biomass

North Tripura district is predominantly a forest covered area People use woody biomass for meeting domestic needs as well as for supplementing the family income through its sale by headloads Commercial headloading is prevalent mainly among the tribal families A significant number of tribal families are involved in collecting fuelwood from the forest since morning to late afternoon for selling it in local market Fuelwood headloads (with each bundle weighing approximately 15 to 20 kg) are sold at a price of ten to fifteen rupees

A large proportion of the people in the district practice shifting cultivation (*jhum*) In this, large area of forest is burnt to clear the existing vegetal growth for creating a patch of open land for raising one or two agricultural crops This piece of land is abandoned upon decline in productivity, and the same exercise is repeated at another site Previously a tribal family would return to an abandoned site after a period of 20-30 years, giving the forest area enough time to regenerate itself However, rapid increase in the local population (including across-the-border migration) along with decline in forest area, has presently reduced this span to merely a period of 5 to 7 years Presence of vast bamboo forests (which come up in drier site conditions) in the place of dense diverse forest is one of the manifestations of persistent *jhuming* According to a survey carried out by the Directorate of Welfare for Schedule Tribes, Government of Tripura, there are 125,916 people practising *jhum* in the North Tripura district Total area under *jhum* is reported to be 23,694 acres of which 4151 acres is currently under cultivation *Jhuming* is believed to one of the major causes of forest degradation and denudation

Unsustainable harvesting of forest resources wherein extractions are much more than what the forest is capable of regenerating over a specified period, is another factor causing degradation. This would not only affect the biomass supply for satisfying daily requirements like fuel and fodder in the short run, but also the availability of commercial products in the long run Moreover, this process may adversely influence the very rate of natural regeneration of forests

Thus, understanding the process and extent of degradation is important for any planning exercise. Therefore, an attempt is made to study the present pattern of production and consumption of forest resources.

Sources of secondary data

Various documents and related information was collected from several government departments in the state These have been studied to compile data on growing stock, sustainable yield and supply of wood Records and the information collected from the forest department provided a lot of information on these aspects

Table 3.1 List of secondary sources

S.No.	Documents	Contents
1	Working plans	History of forests, growing stock, sustainable yield, statistical basis, popular practices, local rights and concessions
2.	Annual administrative reports	Area of forest, volume of wood harvested, encroachments (area lost)
3	Statistical booklet (1989-90)	General information on forest, outturn record, forest type and rangewise area
4.	Report on land use/ land cover, Tripura state, published by National Remote Sensing Agency, Hyderabad	District-wise landuse, vegetation cover on land categories, cultivation practices

History of forests in Tripura

According to the Gazette of North Tripura district, in the past there was no demand for forest products in the local market Forest produce of this state mainly catered to the market of the neighbouring states For the first time in 1887, rules were framed for preservation and improvement of trees, though no area was declared as reserved forest Forest department was created in the year 1913 with subsequent segregation of forests into various divisions.

There was not much change in the administrative and scientific set-up till 1949 when Tripura merged with the Indian Union, and only after that, scientific forestry was attempted for the first time In the First Five Year Plan, 589 hectares of area was brought under afforestation and in the next another 1454 hectares Besides this, reserve forests were also demarcated

Forests in North Tripura

Forests of North Tripura district can be divided mainly into two types: (1) Evergreen, and (2) Moist deciduous forests Bamboo brakes, cane brakes, grasslands, etc are also found in scattered patches all over the district wherever favourable situation exists Forests in this district covers 155787 hectares, occupying approximately 44% of the total geographical area (National Remate Sensing Agency, 1991 Report on Landuse/Landcover, Tripura State) Present status of the forest of the district is shown in the table 3.

North Tripura district is divided into four forest divisions

a) Ambassa
b) Kanchanpur
c) Manu
d) Kailasahar

Data pertaining to forest area under different forest ranges shows that Ambassa, the largest division, has the largest area under forest (1432 43 sq km) and Kanchanpur is the second largest division (1162 30 sq km) followed by Manu division (988 13 sq km) Kailasahar division, on the other hand, has low forest and a large area under agriculture because of flat terrain The division also has towns like Kailasahar and Dharmanagar

Table 3.2. Range-wise area in various divisions of North Tripura

Division	Range	Forest area (ha)
Ambassa Division	Ambassa	18090
	Kamalpur	23069
	Salema	16083
	Geolcharra	6000
	Longithorai	5760
	Raimasama	74241
	Total Area	*143243*
Kanchanpur Division	Kanchanpur	18008
	Kanchanpur S C	34200
	Bhatimachamara	10022
	Juri	24000
	Jampai	30000
	Total Area	*116230*
Manu Division	Dudhpur	14110
	Manu	20482
	Lalcharra	15146
	Chhamanu	49075
	Total	*98813*
Kailasahar Division	Kailasahar	23295
	Kumarghat	16300
	Dharmanagar	30316
	Panisagar	7655
	Paecharthal	3572
	Total	*81138*

Source: Booklet containing statistical figures, 1989-90. Forest department of Tripura.

Growing stock

Growing stock is the volume of biomass from all the trees growing in the forest or a specified part thereof Increase in the volume of this forest crop per unit area in one year is its increment for that period Theoretically, for long term sustainability of a forest area, only this increment should ›e removed from the forest area This volume that can be safely harvested without affec ng the regenerative capacity of the forest stock is known as the sustainable yield F‹ the forests of the district, this yield is taken to be 2% of the growing stock

In all the working plans of North Tripura district, the growing stock and sustainable yield are expressed in terms of area, except for Manu and Kanchanpur forest divisions where sustainable yield is given in terms of the number of trees Area is not a correct indicator of its forest stock for the simple reason that demarcation of forest area is more of an administrative exercise than one having a silvicultural base All the areas that are notified as forests may not have tree cover on them Hence to estimate the growing stock, one needs species distribution in a given forest area As mentioned earlier, the latter two working plans had enumeration details of various species This data was used for calculating average productivity per unit area Range-wise productivity was found to be to be 27 76 cubic meter per hectare (table 3 3)

Table 3.3 Range-wise productivity in different forest divisions

	Forest Ranges	Area (ha)	Volume (cu m)	Productivity (cu m/ha)
Kanchanpur	Deo	18290	16000.38	0 87
	Manu	6734	165440 5	24.57
	Central catchment	5309	417188 9	78 58
	Ujjan	11364	79872 76	7 03
	Juri	3626	144518 9	39 86
	Damchara	5078	74853 6	14 74
Manu	Central Catchment	25287 85	185764	7 34
	Deo	3694 35	119220 1	32 27
	Chandraipara	5477 97	50035 3	9 13
	Ultracharra	659 27	57924 2	87 86
	Longithorai	6366	118809 2	18 66
	Manu Chalingeta	24755 11	302818 9	12 23
Average			144370 6	27 76

This range-wise growing stock was calculated by multiplying species-wise enumeration data, available in the working plans of Manu and Kanchanpur divisions, by volume tables of respective species. This figure when divided with the range area gave the yield of the forests per unit area in terms of cubic meter of wood for the 12 ranges of Manu and Kanchanpur divisions. These figures were averaged to get a productivity figure of all the forest area of North Tripura as this estimated yield represented approximately 49% of the state forest area and there were no estimates for the other divisions of North Tripura district.

In the next step, average wood productivity was multiplied with the area of all the ranges to calculate range-wise growing stock for the entire district (table 3.4) The sustainable yield of woody biomass from the forest areas of North Tripura was worked out at the rate of 2% of the growing stock

Table 3.4 Range-wise growing stock

Forest Division	Forest Range	Forest Area (ha)	Growing stock cu m (tonnes)		SY tonnes
Ambassa	Ambassa	18090	502178 4	334785 6	6695.71
	Kamalpur	23069	640395 4	426930.3	8538 60
	Salema	16083	446464 1	297642 7	5952 85
	Jeolcharra	6000	166560	111040	2220.8
	Longithorai	5760	159897.6	106598 4	2131 97
	Raimasama	74241	2060930	1373953	27479 07
	Total	*143243*	*3976426*	*2650950*	*53019 01*
Kanchanpur	Kanchanpur	18008	499902.1	333268 1	6665 36
	Kanchanpur S C	34200	949392	632928	12658 56
	Bhatimachamara	10022	278210 7	185473 8	3709 48
	Juri	24000	666240	444160	8883 20
	Jampai	30000	832800	555200	11104
	Total	*116230*	*3226545*	*2151030*	*43020 6*
Manu	Dudhpur	14110	391693 6	261129 1	5222 58
	Manu	20482	568580 3	379053 5	7581.07
	Lalcharra	15146	420453	280302	5606 04
	Chamanu	49075	1362322	908214 7	18164.29
	Total	*98813*	*2743049*	*1828699*	*36573.99*
Kailasahar	Kailasahar	23295	646669 2	431112 8	8622.26
	Kumarghat	16300	452488	301658 7	6033.17
	Dharmanagar	30316	841572 2	561048 1	11220 96
	Panisagar	7655	212502 8	141668.5	2833 37
	Pacharthal	3572	99158 72	66105 81	1322 12
	Total	*81138*	*2252391*	*1501594*	*30031 88*

Thus, about 162645 tonnes of wood can be extracted annually from the forest of North Tripura district on a sustainable basis

To find out the share of fuelwood and timber, the yields extracted from various forest divisions in the previous decade were observed. On the basis of these averages about 76% of the total sustainable yield is extracted for fuelwood and 24% is for timber.

Previous fellings

Table 3.5. Species-wise sustainable yield and fraction of fuelwood

Area under felling series (ha)	Annual wood removal (tonnes)	Sustainable Yield tonnes/ha	Fuel Wood (Tonnes)	%age of Fuel wood	Year
Teak Plantation					
476	32359	67 98	21006	64 91	1974
360	25076	69.65	16490	65 76	1975
580	30399	52 41	26566	87 39	1976
681	47629	69 94	31337	65 79	1977
779	54511	69 97	35766	65 61	1978
80	6078	75.97	3674	60 45	1979
95	6615	69 63	4349	65 74	1980
446	31924	71 58	20753	65 01	1981
497	39227	78 93	24700	62 97	1982
Gamar plantations					
145	12300	84 83	10125	82 32	1985
20	2800	140	2500	89 28	1986
15	2100	140	1875	89 28	1987
Misc. Plantations					
73	5840	80	5110	87 5	1969
57	4560	80	3990	87 5	1970
72	5760	80	5040	87 5	1971
31	2480	80	2170	87 5	1974

Mean area under felling series 275 44 ha
Average sustainable yield 81 93 cu m/ha
Net fuelwood available in the district 20059 57 tonnes/ha

Wood Extraction

Major proportion of wood extracted from the four divisions of forest has been in the form of fuelwood till 1984 But the trend changed ever since with the emphasis shifting to timber harvesting It can be seen from table 3 6 below that more than 60% of wood extracted from all the four forest divisions was in the form of timber. The shift took place due to change in the policy of the forest department which banned fuelwood extraction by contractors as well as other agencies, and reserved the right of fuelwood extraction by the local people

Table 3.6 Division-wise out-turn of fuelwood and timber (%)

Year	1980-81		1981-82		1982-83		1983-84		1984-85		1985-86		1986-87		1987-88	
Division	Timber	Fuel	Timber	Fuel	Timber	Fuel	Timber	Fuel	Timber	Fuel	Timber	Fuel	Timber	Fuel	Timber	Fuel
Kailasahar	16 51	83 49	16 55	83 45	28 45	71 55	9 32	90 68	3 81	66 19	52 73	47 27	74 99	25 01	86 95	13 05
Manu	67 94	32 06	44 92	55 08	51 00	49 00	60 11	39 89	16 71	83 29	38 80	61 20	70 13	29 87	54 63	45 37
Ambassa	42 50	57 50	24 21	75 79	32 48	67 52	33 08	66 92	35 25	64 75	10 86	89 14	52 46	47 54	42 53	57 47
Kanchanpur	45 42	54 58	47 42	52 58	60 86	39 14	42 23	57 77	67 79	32 21	73 05	26 95	99 82	0 18	84 65	15 35

Future Projections

Future projections reveal that a trend similar to the existing one would continue Forest department of Kanchanpur division is expected to harvest about 68% of the total sustainable yield as fuelwood However, due to a recent ban on fuelwood extraction, the same may not be harvested According to the forest department, a major share of sustainable yield from the resources shall be fuelwood

Table 3.7. Expected yields in Kanchanpur division

Year	Timber (cu m)	Fuel (cu m)
1989	13059	30690
1990	10933	24255
1991	16310	35381
1992	18269	35141
1993	20521	39541
1994	13110	26420
1995	6356	25574
1996	4342	10624
1997	13172	26402
1998	16604	29375
Mean yield	13267.6	28340 3
	31 89%	68.11%

Summary

The tables presented above and the subsequent discussion show that woody biomass meets a variety of requirements of the people in the district apart from generating large revenues for the government through the trade of various forest products Timber, the main product of forest, and bamboo are used in construction, furniture, etc As the data reveals, wood has been the traditional fuel used for cooking and space-heating Apart from these, forest also provides large quantities of minor produces (MFP) like bamboo, tamarind, gum and fruits

Animal Waste

Availability of animal waste primarily depends on the cattle population, feeding and grazing practices In North Tripura district the quantity and quality of cattlefeed is poor according to the district veterinary officials

While considering the possible energy uses of animal waste, the competing non-energy uses have also been considered in addition to the availability As evident from the primary survey, the most important non-energy use of dung is mud-plastering and as farm yard manure The amount of dung used for farm yard manure can be diverted for energy uses without a conflict in the end-uses through biogas technology Keeping this

in mind and using the results of the primary survey (approximately about 3 kg per cattle per day), block-wise availability of dung is arrived at (table 3 8)

Table 3.8 Block-wise cattle population in North Tripura district

Block	Cows	Buffaloes	Total	Dung (wet) available '000 t/y	Dung (dry) available '000 t/y
Kumarghat	53903	5247	59150	64 77	12.95
Chamanu	28566	116	28682	31 41	62 81
Panisagar	59036	1556	60592	66.35	13.26
Kanchanpur	38915	472	39387	43 13	86 25
Salema	48836	1497	50333	55 11	11 02

Source Veterinary Department, North Tripura district

The above table reveals block-wise estimates of the availability of dung (both on wet and dry basis) Kumarghat and Panisagar blocks have the highest annual wet dung availability of 77,720 tonnes and 79,610 tonnes, respectively These two blocks are also agriculturally prosperous After Kumarghat and Panisagar, Salema has the highest availability of dung

Kerosene

In the mix of fuels otherwise dominated by non-commercial fuels, kerosene plays an important role in the rural areas, being the principal fuel used for lighting. Studying the supply system of kerosene in a remote district like North Tripura is important as it determines the accessibility of the fuel to the population

For this purpose, data was collected from the district headquarters In addition, a primary survey of consumers has been conducted as part of the study to know the overall energy consumption pattern

Distribution of Kerosene

Kerosene in North Tripura district is supplied through the public distribution system (PDS) involving a number of organisations at various levels The overall responsibility of ensuring a regular supply lies with the District Collector However, on the operational side, the key role is played by wholesalers who get the supplies directly from the oil companies

The details of monthly supplies of kerosene to the wholesalers for distribution through cooperative sector and the non-cooperative sector, and the towns/blocks covered by the wholesalers are given below.

Table 3.9. Monthly allotment of kerosene in North Tripura

Month	Kumarghat		Panisagar		Kanchanpur		Chhamanu		Salema	
	1991	1993	1991	1993	1991	1993	1991	1993	1991	1993
Jan	240	0	300	0	0	0	0	0	116	0
Feb	240	0	399	0	0	0	0	0	116	0
March	0	0	0	0	0	0	0	0	0	0
April	145	132	167	170	0	40	0	50	70	90
May	183	132	201	170	0	40	0	50	80	90
June	153	1132	161	150	0	40	0	50	70	90
July	153	133 2	161	171 2	0	30 6	0	40	70	70 8
Aug	145	0	166	0	0	0	0	0	78	0
Sep	0	142 2	0	161 2	0	39 6	0	48	0	91 2
Oct	148	160 2	166	202 8	0	0	0	48	78	120 6
Nov	178	157.8	206	162 4	0	40 8	0	51	91	120 6
Dec	0	157	0	162 4	0	40 8	0	0	0	120 6

Source Food and Civil Supply Dept, Kailasahar

Electricity

Almost all the towns of the district and the block headquarters are electrified, the main use of electricity being lighting Electricity supply for the district has been very limited till recently with diesel providing most of it The first and only one hydro-electric station in Tripura was commissioned in 1976-77 on river Gumti in South Tripura district Electricity is also made available from the Gas Thermal Project at Baramura The diesel power generating stations at Dharmanagar, Kailasahar and Ambassa have been retained as standby generating stations

Table 3.10 Rural electrification

S No	Sub-division	No of electrified villages
1	Kanchanpur	50
2	Dharmanagar	135
3	Kailasahar	180
4.	Kamalpur	262
	Total	627

Source: Service Area Credit Plan (1992-93), United Bank of India

The above table reveals that situation of rural electricity is yet to be widespread in the district About 627 villages are electrified out of the total of 1133 villages accounting for 55 34% compared to 84% of the villages in the country

Conclusion

As is evident from the scenario described above, the energy supply system is dependent mainly on the biomass fuels, which is likely to continue in the future One of the major implications of this situation is that the energy plan envisaged for the district has to revolve primarily around the biomass resources and promote efficient use of biomass technologies At the same time, it also indicates the need to strengthen the supply system of commercial fuels, and improve electricity supply through decentralized options such as renewable energy technologies An attempt has been made in the subsequent chapters to reflect some of these concerns in preparing the energy plan

CHAPTER 4

Energy Demand

In order to prepare an effective energy plan which could be implemented, it is necessary to have an estimate of the energy demand for different enduses over a definite time period The specified energy demand can be estimated either by conducting a survey of the existing energy consumption pattern and extrapolating the consumption figures to get the demand, or by using normative values available based on the past data[1] However, in the case of North Tripura district, which has a distinct ecosystem comprising plains, hillocks as well as high hills, no studies were conducted in the past Therefore, a primary survey was conducted at the household and village level, and the data has been analyzed and aggregated at the block and district levels Major enduses considered were cooking and lighting in the domestic sector which are the largest energy-consuming enduses

Methodology

Aggregating energy demand at a higher level unit (block) after collecting data at the lower level unit (village) requires selection of a statistically representative sample. The procedure followed for selection of sample villages for energy demand estimation is addressed in this section The results of the survey are presented in this chapter and it concludes with estimates of the aggregate demand at the two categories of settlements or villages

Sampling procedure

Sample surveys are resorted to in order to obtain information pertaining to parameters (in the present context, these are the energy consumption figures for different enduses) whose complete enumeration or measurement is physically not possible in practice, as would be the case in North Tripura district Sampling is a procedure of selecting units from the population (of whose parameters are to be measured) such that "the selected

[1]Earlier, various committees set up by the Government of India to look into energy policy, such as Working Group on Energy Policy and Advisory Board on Energy, worked out consumption norms for different fuels at the national level Also, a Rural Energy Database was created by the Tata Energy Research Institute (TERI) which compiled village level data in different agro-climatic zones as categorized by the Planning Commission This database would give consumption data at the level of various administrative units (district, block, village, etc) based on the surveys conducted in the past

units are representative of the population as a whole in terms of the parameters that the survey aims to measure or estimate" (Sukhatme and Sukhatme 1974).

In the context of the variety of items on which information is sought through a survey for rural energy planning, the selection of sample is a complex task. The process is further complicated by the fact that the sample selection methodology depends crucially on the nature of the dependence of the parameter on different variables in the population

The incomplete quantitative understanding of the different components of the energy system in rural areas would indicate that efforts be made to evolve a sample selection procedure that provides greater insights into the rural energy system. For energy demand it seems desirable to select sample villages on two parameters 1) per capita availability of forest land, and (2) per capita agriculture land

These parameters are assumed to reflect the stress and/or availability of biomass energy resources on which the village of North Tripura district is based Also, as the economy is based largely on agriculture, agricultural land would be a surrogate variable for income.

In addition to the land-related parameters, one more indicator has also been considered in choosing the sample villages· the *Order* of the settlement (village) The 'order' is dependent not only on the demographic characteristics, but also on the level of infrastructural facilities, and differs in the general occupation pattern While using this criterion, it is also assumed that the 'order' would have assured incomes, higher purchasing power, greater access to fuels markets, etc. To define the 'order' of settlements, a weighted index method is used in which weights for a range of infrastructural indicators[2] are worked out[3] For example, there are 266 settlements in North Tripura having 668 primary schools and 71 junior high schools, and the weights are computed as follows

[2]The village-wise data on infrastructure indicators have been taken from the District Census Handbook of North Tripura

[3]Post office, sub-post office, telephone and telegraph facilities
Banks and other financial institutions and cooperatives
Educational facilities primary, middle, high school and other higher level and technical institutions both public and private
Medical and health services including sub-centres, primary health centres, hospitals, specialised hospitals, private nursing homes, dispensaries, ayurvedic, unani and homeopathic dispensaries and private medical practitioners
Veterinary services including stockmen centre, A I sub-centre, veterinary hospital

Table 4.1 Weighted index method

Facility	Weight
Primary school	266/668 = 0 4
Junior high school	266/71 = 3 75

Having derived the weight of all the functions by the above procedure, weights for all the functions were added up to arrive at the Composite Functional Index (CFI)[4] Having worked out the CFI for all the settlements in the district, the mean CFI was computed, and the 'order' of settlement was found out in the following manner

Order	Criteria
Higher order settlement	> mean CFI + 2xStandard Deviation (I)
Medium order settlement	> II and < I
Low order settlement	> mean CFI + Standard Deviation (II)

Using this method, all the 266 villages in the district have been categorized However, it was found in the analysis that none of the villages has fallen into the middle level category Therefore, only two 'order' of settlements (High as *First* order settlement, and low as *second* order settlement) were considered for the purpose of sample selection.

Sample selection

Apart from the settlements, the village level data in the Census Handbook has also been used to compute the per capita forest land and per capita agricultural land

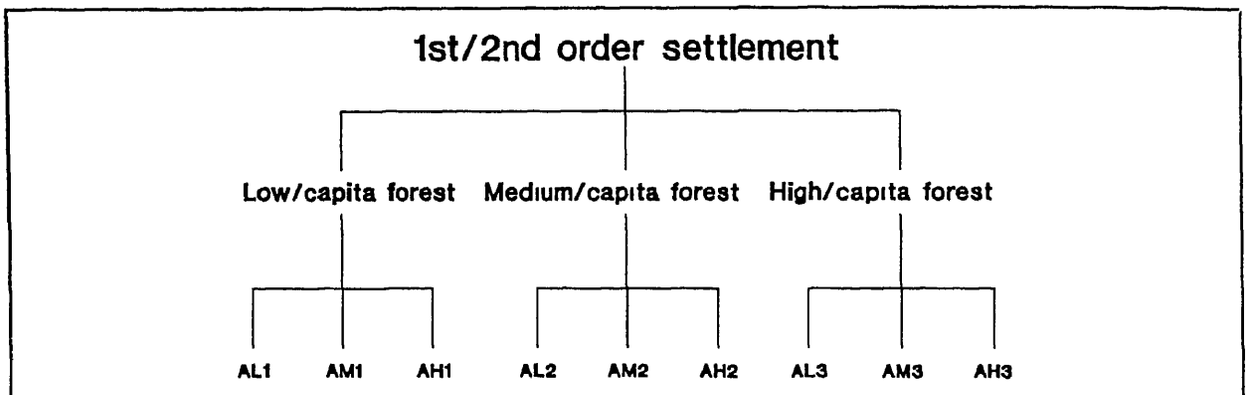
Then the villages were grouped block-wise, into six categories viz high forest,medium forest,low forest,high agriculture,medium agriculture and low agriculture Categories for were derived by the following method

- **High** category is taken to be > (Average per capita + 0 5 Standard deviation)
- **Medium** category is taken to be lower limit of the high and higher side of Low
- **Low** category is taken to be < (Average per capita - 0 5 Standard Deviation)

[4]This is a standard methodology developed by Planning Commission (See Report of the Working Group on District Planning, Vol I, Planning Commission May 1984)

In order to make field survey statistically representative, sample villages were selected randomly from each category as shown below. First villages were categorized according to their development order. In the next stage these villages were categorized on the basis of per capita forest land i e. high, medium and low per capita forest land for both the development orders In the next stage villages from each category of per capita forest land were categorized according to per capita agricultural land availability (Fig 1). A similar procedure for selection of villages was adopted for sample selection in the II order of settlement. For primary survey, villages were picked randomly from each category.

Figure 4.1. Matrix of sampling parameters

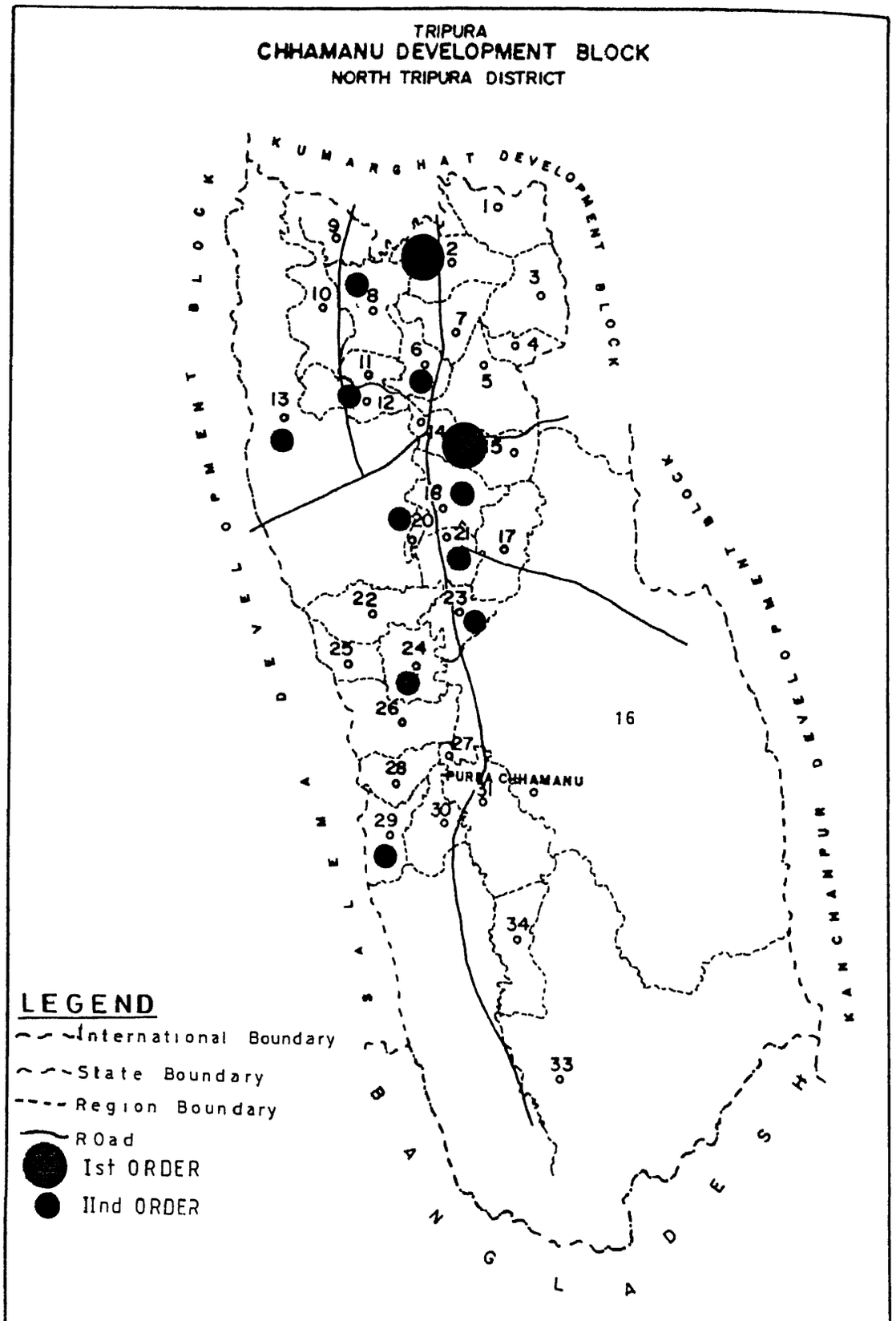


Before carrying out the primary survey in the field, the list of sample villages chosen was discussed with various block development officers in the district to verify the logistical and other constraints including the law and order situation The list of selected villages is presented in table 4.2

Table 4.2. Villages selected for primary survey

Block Chhamanu

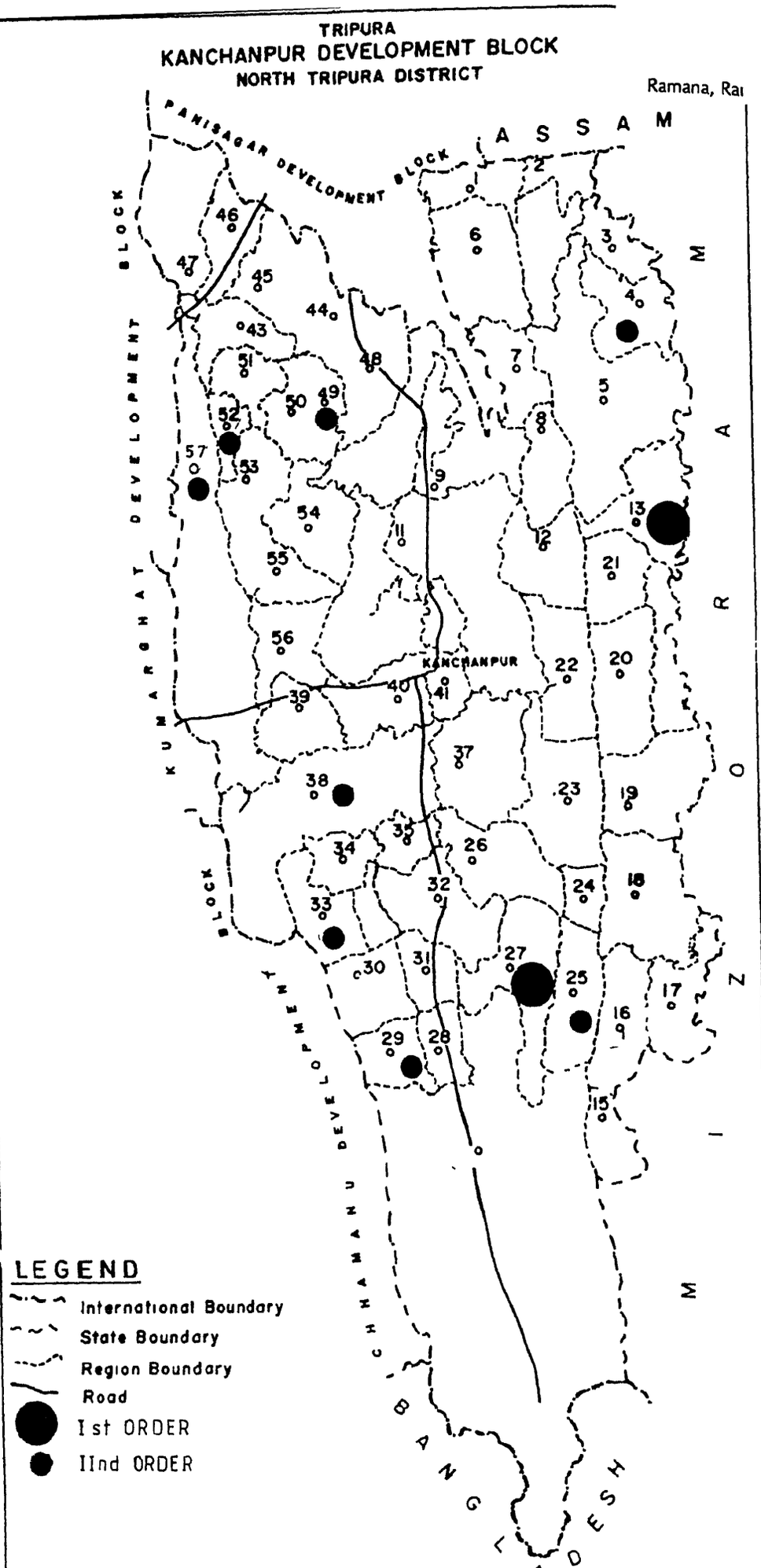
S No	Village name	Attribute 1	Attribute 2	Attribute 3
		Settlement order	Per capita forest land	Per capita agriculture land
1	Manikpur	II	Low	High
2	West Chhamanu	II	Low	Low
3	Jaichandrapara	II	High	Medium
4	Kanchan Cherra	II	Medium	Medium
5	South Dhumecherra	II	Low	Low
6	East Kathalcherra	II/I	Medium	Low
7	Manu	I	Low	Low
8	Moinama	II	Low	Medium
9	Goinama	II	Low	Medium
10	Chailengta	I	Low	Medium
11	East Mashli	II	Low	Low
12	Nalkata	II	Medium	Low



MAP SHOWING VILLAGES SELECTED FOR PRIMARY SURVEY

Block Kanchanpur

S No	Village name	Attribute 1	Attribute 2	Attribute 3
		Settlement order	Per capita forest land	Per capita agriculture land
1	Nabin Cherra	II	Medium	High
2	Karai Cherra	I	Medium	Medium
3	West Satnala	II	Low	Medium
4	Dasda	I	Low	Medium
5	Kanchan Cherra	II	Medium	Low
6	North Machmara	II	Medium	Medium
7	Shantipur	II	Low	Medium
8	Vangmun	II	High	Low
9	Bilianchief	II	High	Low
10	Tlang Sang	II	High	Low
11	Lal Juri	II	Low	Medium



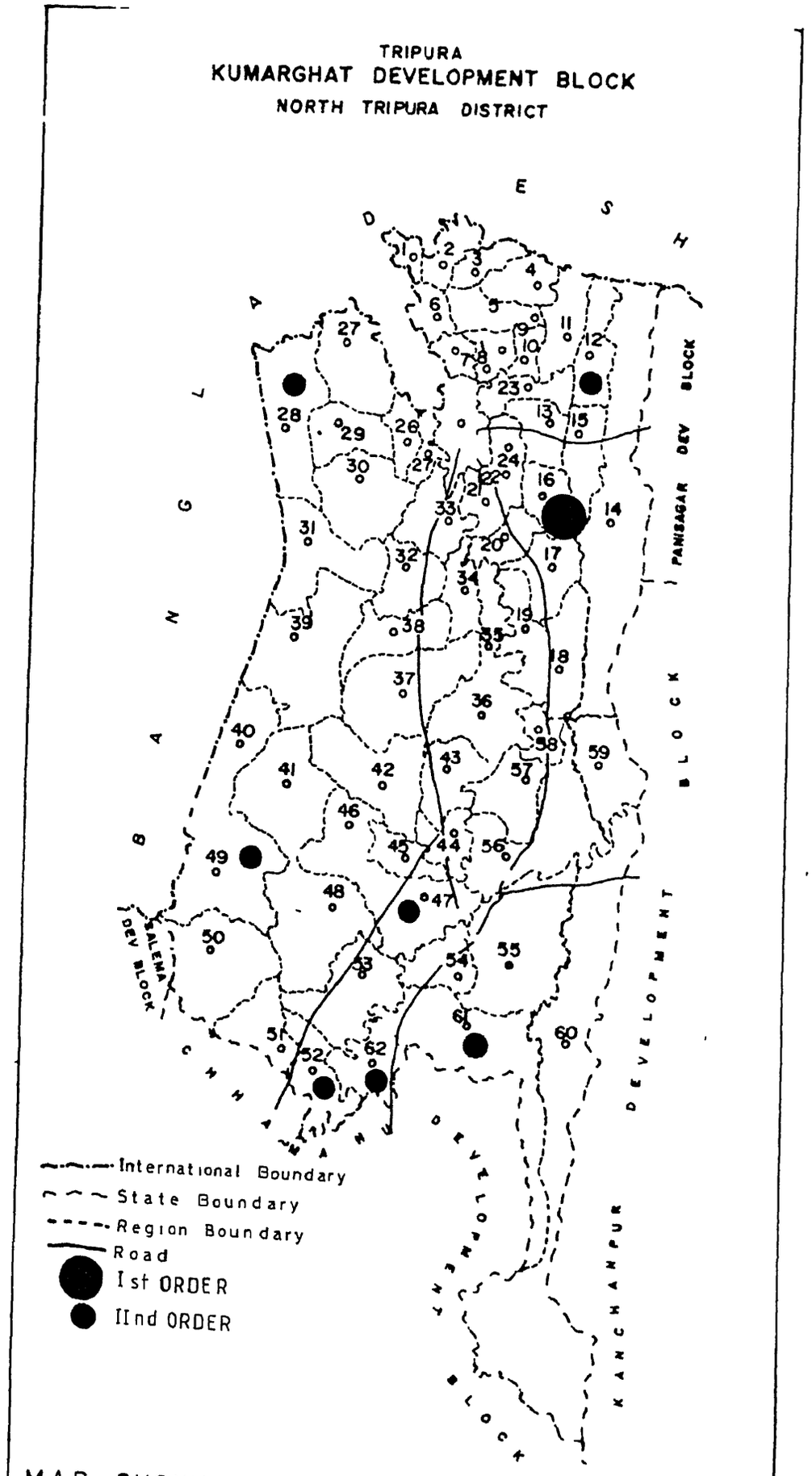
MAPS SHOWING VILLAGES SELECTED FOR PRIMARY SURVEY

Block Kumarghat

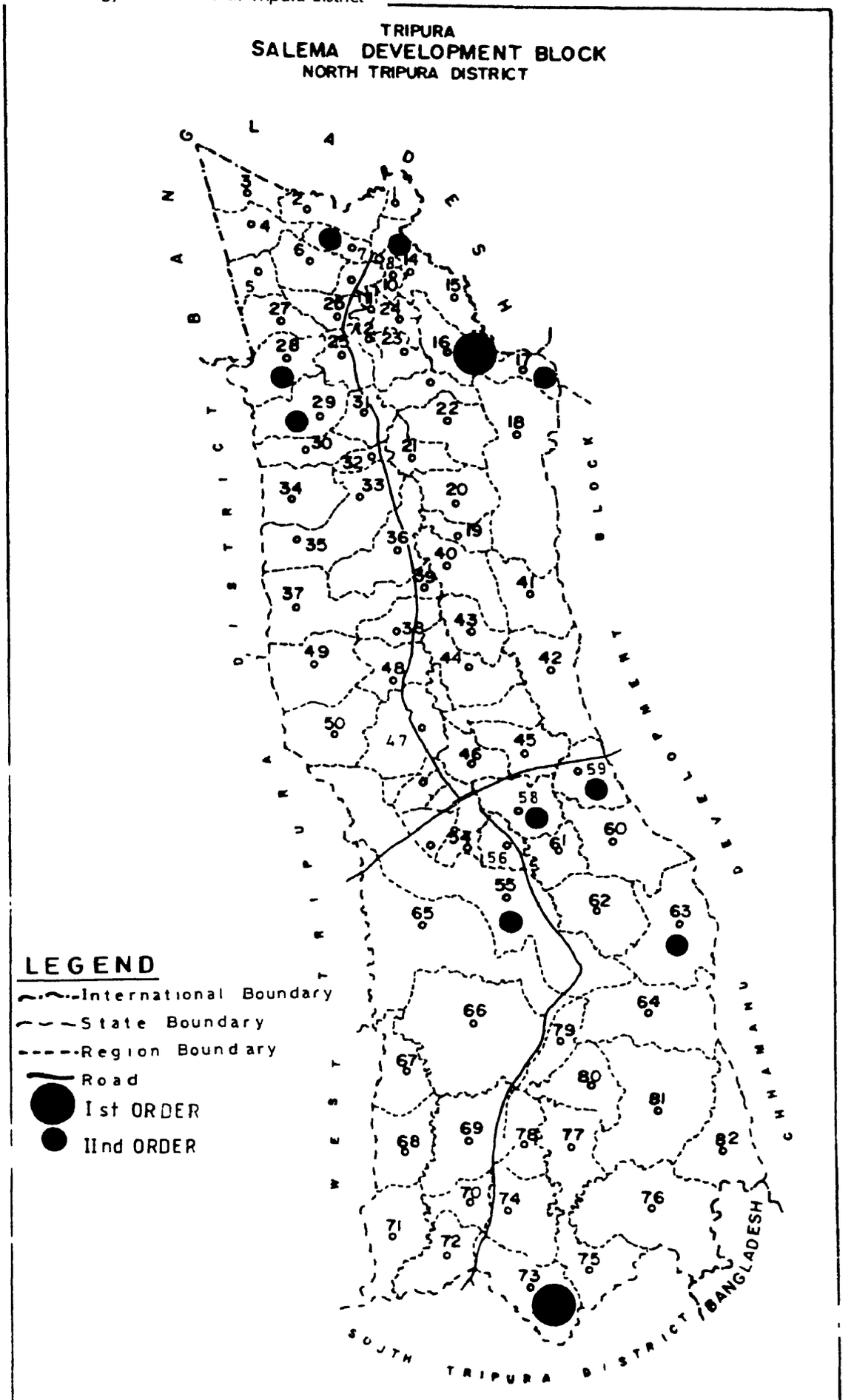
S.No	Village name	Attribute 1	Attribute 2	Attribute 3
		Settlement order	Per capital forest land	Per capital agriculture land
1	Rangauti	II	Low	Medium
2	Tilagaon	II	Low	Medium
3	Unakoti	II	High	Low
4	Dhaliarkhandi	II	Low	Low
5	Jolai	II	Low	Medium
6	Ratachara	II	Low	High
7	Fatikroy	I	Low	Low

Block Salema

S No	Village name	Attribute 1	Attribute 2	Attribute 3
		Settlement order	Per capital forest land	Per capital agriculture land
1	Hala Huli	II	Low	Medium
2	Bilascherra	II	High	Low
3	Chota Surma	I	Low	Low
4	Salema	I	Low	Low
5	Hala Hali	II	Low	Medium
6	Baman Cherra	II	Low	Medium
7	Chulu Bari	II	Low	Medium
8	Manik Bhandar	II	Low	Medium
9	Maya Cheri	II	Low	Medium
10	Naogan	II	Low	Low



MAP SHOWING VILLAGES SELECTED FOR PRIMARY SURVEY

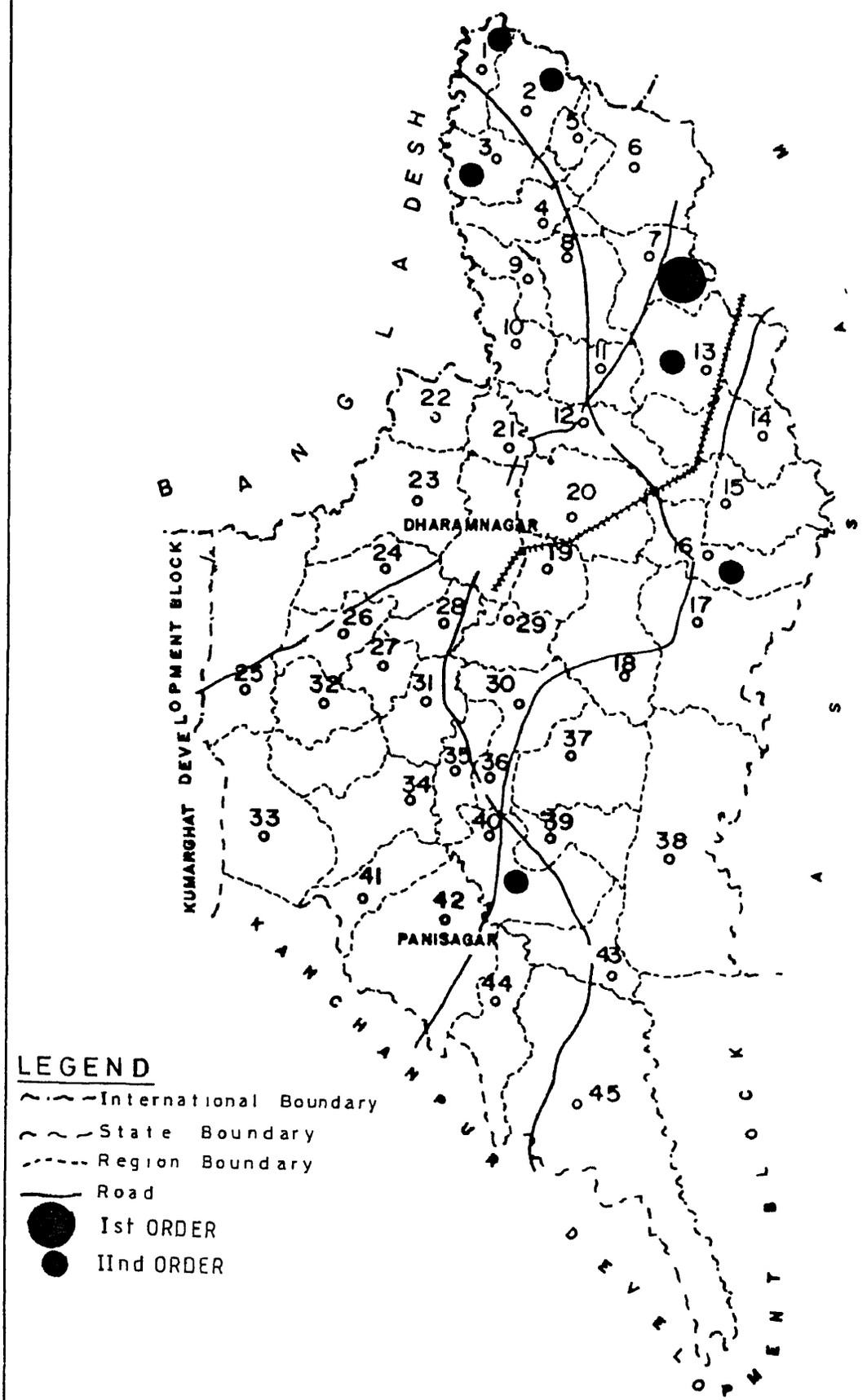


MAP SHOWING VILLAGES SELECTED FOR PRIMARY SURVEY

TRIPURA

PANISAGAR DEVELOPMENT BLOCK

NORTH TRIPURA DISTRICT



MAP SHOWING VILLAGES SELECTED FOR PRIMARY SURVEY

Block Panisagar

S.No	Village name	Attribute 1	Attribute 2	Attribute 3
		Settlement order	Per capital forest land	Per capital agriculture land
1	Ichhailal Cherra	II	Low	Medium
2	Balidum	II	Medium	High
3	Sanichhera	II	Low	Medium
4	North Dhupriband	II	Low	Medium
5	Bagbassa	II	Medium	Low
6	Baruakhandi	II	Low	Low
7	Alagpur	N A	N A	N A

Survey instruments

Structured questionnaires have been used as the survey instrument which had two components village schedule and household schedule (annexure I) The final sample covered was 47 villages and 525 households The data was then compiled on mastersheets in hand by the study team responsible for the survey These were then computerized, processed and analyzed using the statistical software, QPRO

Survey Results

The statistical properties of these variables are summarized in Table 4 3. The properties of some variables have been given for their per capita and per household values

Table 4.3 Summary of data for per capita and per household values

Variables	Unit	N Tripura	I order	II order	Std D	Min	Max
Electrified	(%)	0 05	0 04	0 06	0 50	0	1
			Family size				
Men	NO /hh	1 86	1 84	1 95	1 49	0	9
Women	NO /hh	1 75	1 76	1 71	1 37	0	10
Children	NO /hh	1 65	1 67	1 60	1 74	0	16
Go out side the vill For employment	(%)	17 12	17 28	16 55	0 39	0	1
Distance	Km /HH	2 97	2 40	5 15	11 03	0	200
			Food consumption				
Rice	kg/d/pc	0 58	0 58	0 57	1 87	1	15
Wheat	kg/d/pc	0 02	0 02	0 02	0 13	0	4
Pulses	kg/d/pc	0 03	0 03	0 03	0 22	0	2
Vegetables	kg/d/pc	0 32	0 31	0 36	1 12	0	8
Meat	kg/d/pc	0 12	0 13	0 07	15 28	0	2 5
Fish	kg/d/pc	0 33	0 36	0 19	46 30	0	8
Avg Daily milk production	kg /hh	0 29	0 28	0 31	0 66	0	12
Self consumption	kg/d	0 19	0 18	0 21	0 51	0	7
Sale	kg/d	0 05	0 04	0 10	0 31	0	10
Price	Rs kg	0 22	0 20	0 33	2 14	0	12
Time spent in cooking	hrs/d/hh	3 74	3 66	4 07	1 10	1	12
Cooking inside	Y/N(%)	72 92	70 36	82 73	0 00	1	1
Monthly energy expenditure	Rs HH	43 10	36 03	70 17	105 17	0	1500
			Chulha use for cooking				
Summer	hrs/d/hh	3 24	3 14	3 61	1 13	2	12
Winter	hrs/d/hh	3 77	3 69	4 11	1 09	2	12
			Chulha use for water heating				
Summer	hrs/d/hh	0 08	0 09	0 03	0 14	0	2
Winter	hrs/d/hh	0 37	0 41	0 22	0 32	0	7

Variables	Unit	N. Tripura	I order	II order	Std D	Min	Max
			Monthly electricity bill				
Electricity bills	Rs/M/HH	9.48	8.69	12.53	25.67	0	250
Lighting devices used total	hrs/d/hh	4.09	3.95	4.62	1.24	0	12
Study	hrs/d/hh	0.76	0.76	0.78	1.55	0	6
General	hrs/d hh	3.33	3.19	3.83	1.24	0	12
Total bulbs	No./hh	1.31	1.21	1.72	3.68	0	17
Total lantern	No./hh	0.88	0.91	0.76	1.25	0	10
Total diya	No. hh	2.41	2.49	2.10	1.57	0	59
Total kerosene consumption	lit/M/hh	4.31	4.28	4.42	3.46	0	59
Amount spent for kerosene	Rs/m/hh	15.54	15.33	16.34	44.20		
Total hours for space heating	hrs/d/hh	0.26	0.26	0.24	0.44	0	5
			Land ownership				
Total agricultural land	Kani hh	2.94	2.99	2.73	6.68	0	38
Good agricultural land	K ani hh	2.15	2.14	2.22	3.48	0	30
No. of pieces	No. hh	0.89	0.88	0.95	1.37	0	10
Area irrigated	K ani hh	0.93	0.93	0.95	2.56	0	30
			Live stock				
Cow	No. hh	1.0	0.46	0.48	0.94	0	7
Calves	No. hh	0.45	0.44	0.48	0.84	0	4
Bullocks	No./hh	0.57	0.56	0.58	1.17	0	6
Buffaloes	No./hh	0.03	0.03	0.02	0.09	0	3
Goat	No./hh	0.73	0.78	0.57	1.35	0	16
Sheep	No./hh	0.01	0.01	0.00	0.00	0	3
Stallfed	Cow	42.67	40.13	52.59	0.50	0	1
Avg. distance travelled for grazing	Km. hh	0.68	0.65	0.89	0.91	0	5
			Domestic consumption of dungcake				
Cooking+waterheating	No.d hh	0.07	0.09	0.02	3.69	0	20
			Firewood				
Cooking+waterheating	Kg d hh	11.75	11.57	11.91		0	50
Space heating	Kg d hh	1.95	1.98	1.91		1	15
			Electricity				
Lighting	hrs d hh	1.05	0.94	1.65		0	12
			Kerosene				
Cooking+waterheating	lit M hh	0.21	0.26	0.04		0	11
Lighting	lit M hh	3.95	4.24	3.67		0	30

Variables	Unit	N Tripura	I order	II order	Std D	Min	Max
			Collection of wood				
No of persons collecting	No /hh	0 76	0 80	0 57	0 77	0	7
Avg time spent for collecting days/week	d/week/hh	1 64	1 70	1 39	2 24	0	7
Trips made by one person	Trips/d/hh	1 25	1 47	0 43	0 46	0	2
Total quantity collected	Kg/p/Trips	2 90	3 03	2 44	16 14	0	70
Distance travelled	Km/hh	0 80	0 80	0 81	1 20	0	8
						Use of Timber	
Construction	Y/N(%)hh	0 67	0 63	0 82	0 00	0	1
Agri Implement	Y/N(%)hh	0 38	0 39	0 31	0 49	0	1
Furniture	Y/N(%)hh	0 48	0 47	0 52	0 47	0	1
Dung	Y/N(%)hh	0 53	0 51	0 57	0 50	0	1
Plastering	Kg/Time/hh	0 85	0 91	0 63	0 84	0	12
	Time/M	6 01	5 53	7 86	8 59	0	30
			Family income				
Total expenditure	Rs/M/HH	933 56	906 51	1037 18	1060 03	0	8000
Total income	Rs/M/HH	1095 98	1009 21	1428 40	1475 57	0	10000
Total saving	Rs/M/HH	162 43	102 70	391 23			
			Scarcity indicators				
Perceive wood scarcity	Y/N(%)hh	18 69	17 10	24 82	0 37	0	1
Present firewood Cons Vary from past	Y/N(%)hh	27 40	27 35	27 58	0 49	0	1
Increased/decreased	I/D(%)hh	69 64	66 22	82 73	0 00	0	1
Fuel for special requirement purchased	(%)hh	25 97	22 31	39 98	0 42	0	1
			Cycle for crop production				
Rabi crop							
Productivity	Kg/Ac	101 20	101 25	100 99	280 16	0	370
Total no of days	No	2 55	2 65	2 14	5 02	0	90
Animal used	Own/Rented	0 06	0 07	0 01	0 00	0	1
			Total no of mandays				
Self	No /hh	1 42	1 65	0 55	1 37	0	600
Labour	No /hh	0 12	0 13	0 11	0 19	0	10
No of hours motor used tractor/power tillers	hrs/hh/season	0 07	0 09	0 00	0 00	0	15
Amount spent/hh/season	Rs/hh/season	7 84	9 03	3 27	0 00	0	2400
Avg time spent/day	hrs/d/hh	0 04	0 05	0 00	0 19	0	6
Total diesel/electric consumption	Rs/Season/hh	2 13	3 07	0 00	5 08	0	810

Variables	Unit	N Tripura	I order	II order	Std D	Min	Max
			Kharif crop				
Productivity	Kg/Ac	215 48	221 79	191 30	208 74	0	200
Total no of days	No /hh	5 92	6 07	5 36	8 88	0	90
Animal used	Own/Rented	0 00	0 00	0 00	0 00	0	1
			Fuel preferences				
Total area (jhum)	Kani/hh	0 45	0 54	0 09	2 85	0	13
			Productivity of major crops				
Dhan	Kg Kani/hh	12 13	13 42	7 17	57 96	0	500
Til	Kg Kani hh	2 04	2 50	0 28	12 58	0	100
Maize	Kg/Kani hh	2 37	2 66	1 24	19 61	0	70
Cotton	Kg Kani/hh	1 70	2 06	0 50	12 42	0	60
All vegetables	Kg/Kani/hh	11 23	13 02	4 34	64 27	0	400
Time taken in sowing	d/Kani/hh	0 16	0 17	0 12	1 74	0	12
Time taken in preparing	d Kani/hh	1 45	1 80	0 14	6 94	0	60

Presentation of data

The collected data on over 525 variables at the household level for different orders of settlements were thus tabulated and analyzed The analysis was directed towards examining the statistical distribution of the data on different parameters

Survey Results

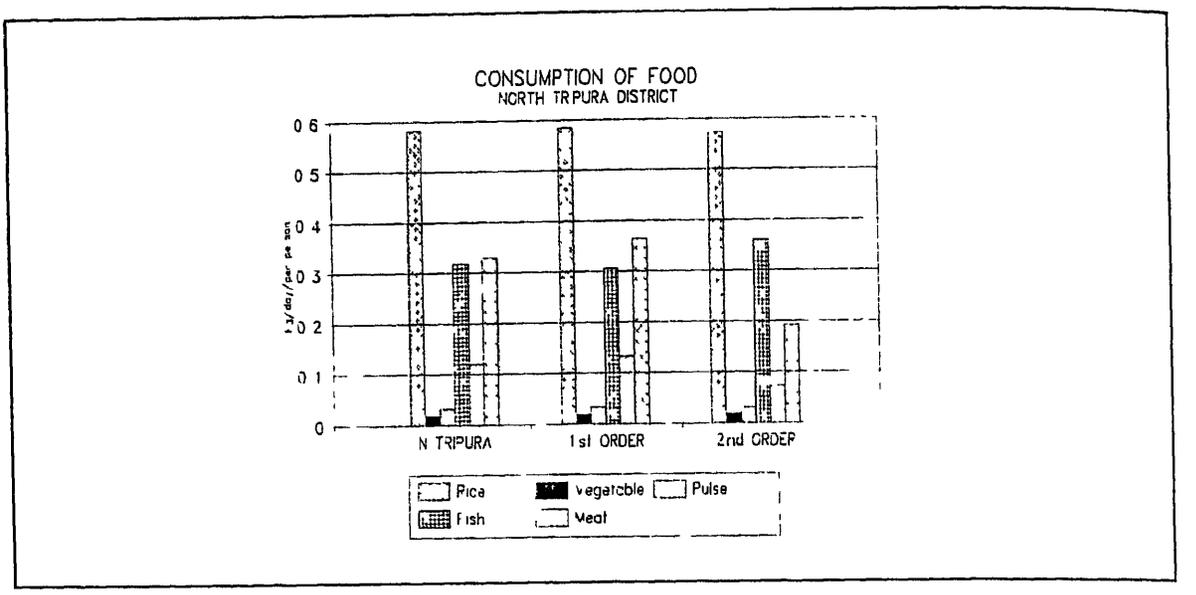
Family size

The average family size among the surveyed households in the district is 5 26 members But the number of children in the surveyed households varied from a maximum of 16 to a minimum of zero and the average number of children per household is 1 65 (with a SD of 1 74)

Eating and cooking habits

Main foodgrains are rice among all households, an average of 0 58 kg per person (with an SD of 1 87) of rice was consumed daily (Figure 4 2) The average consumption of vegetables 0 32 kg per person (with an SD of 1 12 kg) is high compared to pulses which is only 0 03 kg per person (with an SD of 0 22) Fish accounts for 0 33 kg per person (with an SD of 46 30) followed by 0 12 kg of meat per person per day (with an SD of 15 28)

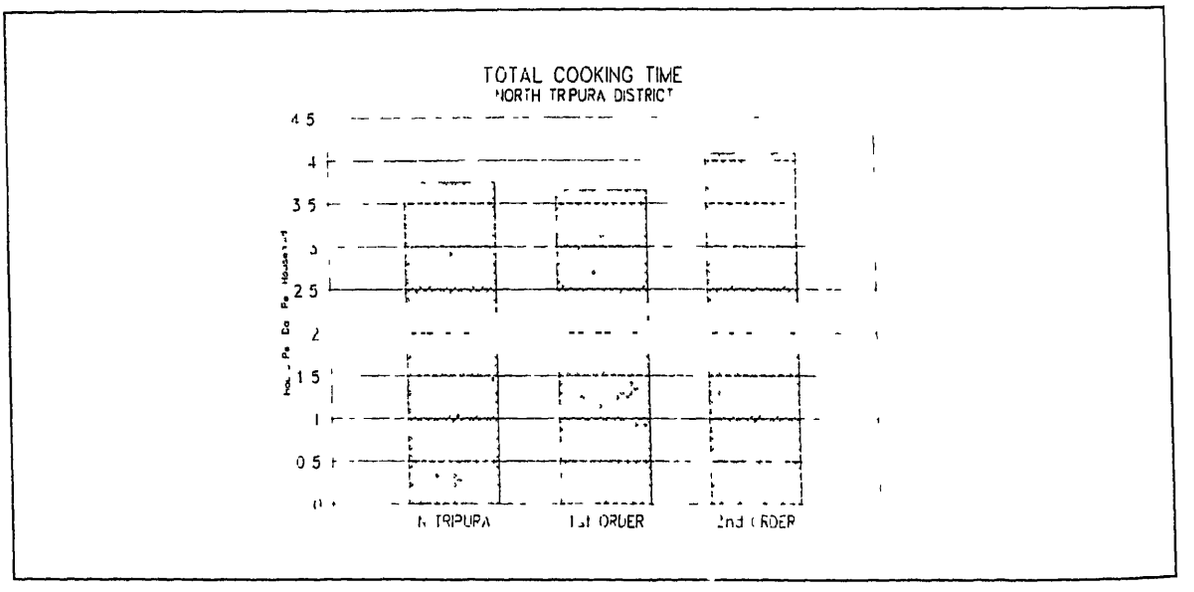
Figure 4.2 Consumption of food



Time spent in cooking

Average time spent in cooking per household is 3 74 hours/day/household (with an SD of 1 10) (Fig no 4 3) Time spent for cooking in the first order of settlement is 3 66 hrs/d/hh and the second order of settlement 4 07 hrs/d/hh This is because kerosene is used for cooking more in I order settlements than the II order settlements

Figure 4.3 Total cooking time (hr/d/hh)



Use of chulha for cooking and water-heating

Average cooking time (or the use of the chulha) is 3.77 hrs/d/hh in winter (with an SD of 1 09) and 3 24 hrs/d/hh in summer (with SD of 1 13) (figures 4 4 and 4 5) The extra cooking time (or the use of the chulha) in winter is partially for space heating and partially due to the higher energy requirement for cooking and other tasks in winter

Figure 4.4 Use of chulha for cooking (h/d)

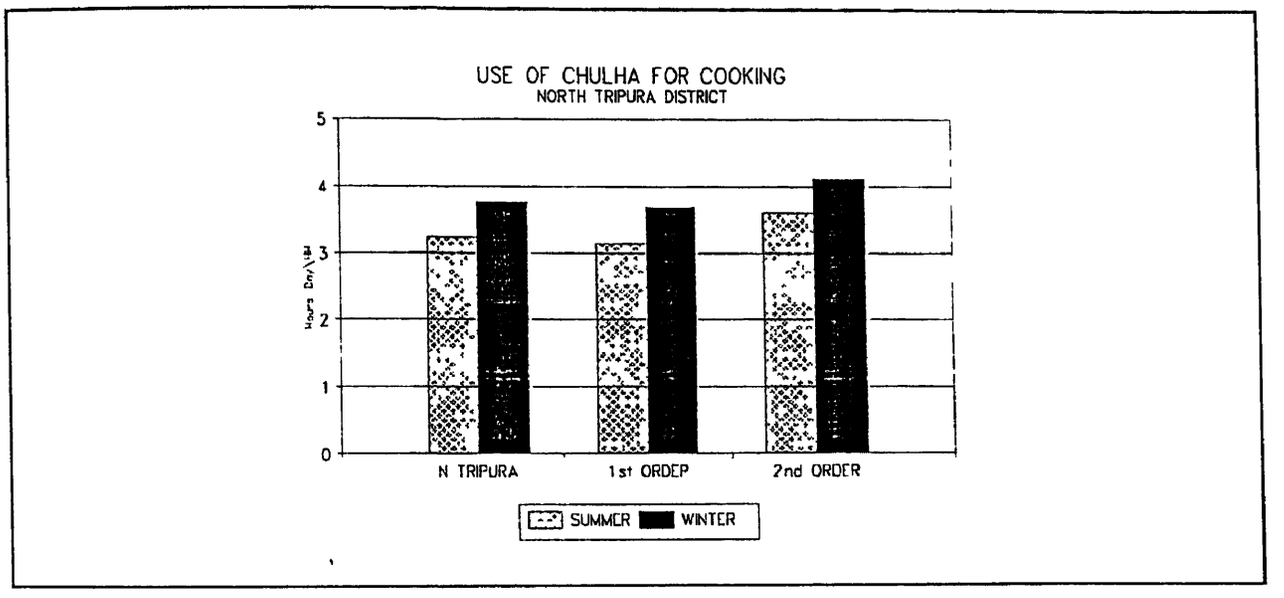
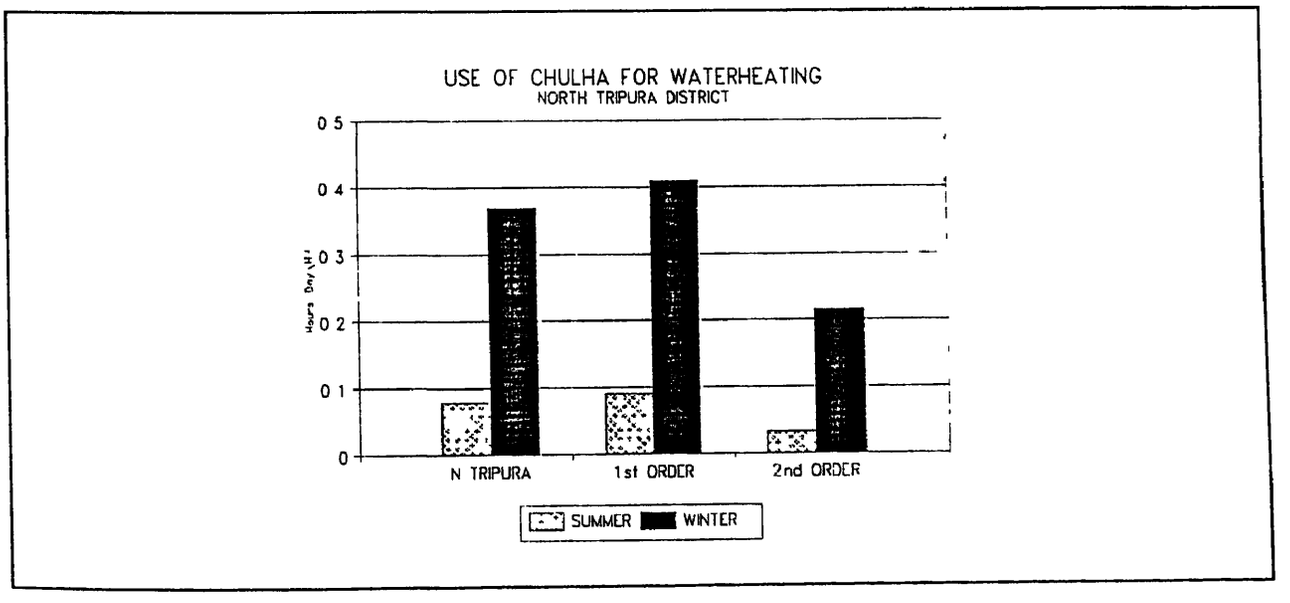


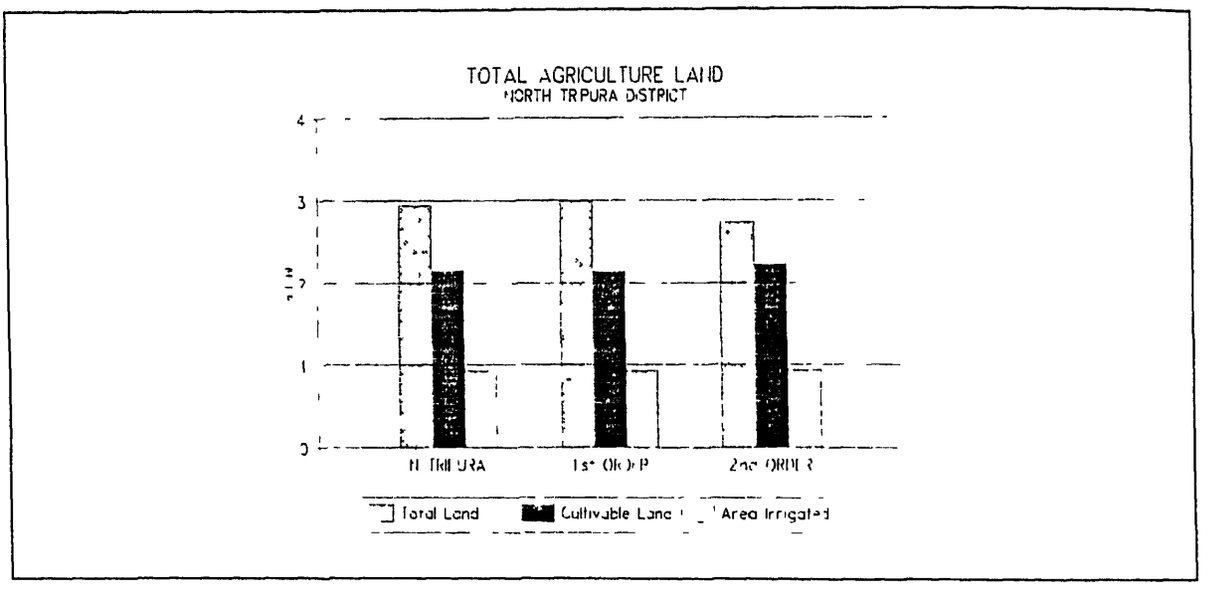
Figure 4.5 Use of chulha for water-heating



Land-holding and other assets

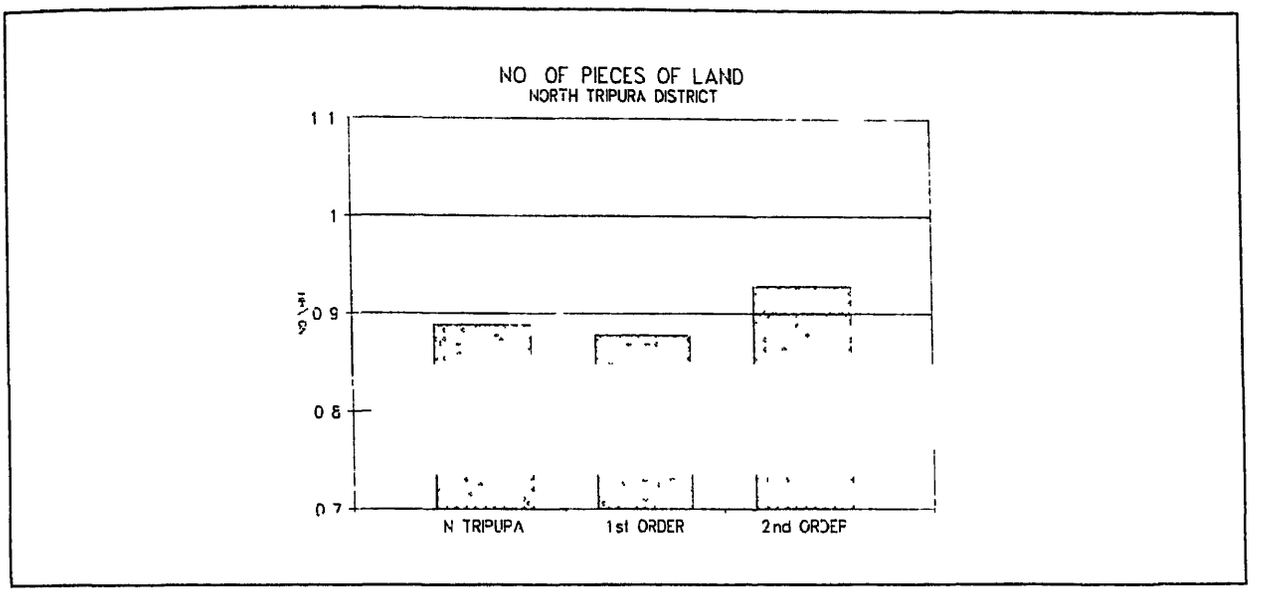
The average holding of a household is about 2 94 *kani* (with an SD of 6 68) Although per capita land holding is higher in I order settlements about 2 99 kani than in II order settlements which is about 2 73 *kani* But good agricultural land is higher in the II order settlements standing for 2 22 kani (81 32% of the total agricultural land) Availability of good agricultural land stands true for only *kharif* season during which crop is grown on almost whole land, and not in *rabi* season when lack of irrigation facility limits the cultivated area

Figure 4.6. Total per capita agriculture land



Fragmentation of land is another problem in the district as in many other places in India Nearly a third of the landowning respondents, however, reported less than a single plot of agricultural land The average number of plots is about 0 89 (with SD of 1 37) among the surveyed households and the distribution is depicted in Figure 4 7 In the case of per household number of holdings, II order settlement is slightly better than the I order settlement where number of pieces per household is 0 93 *kani* as against 0 88 *kani*

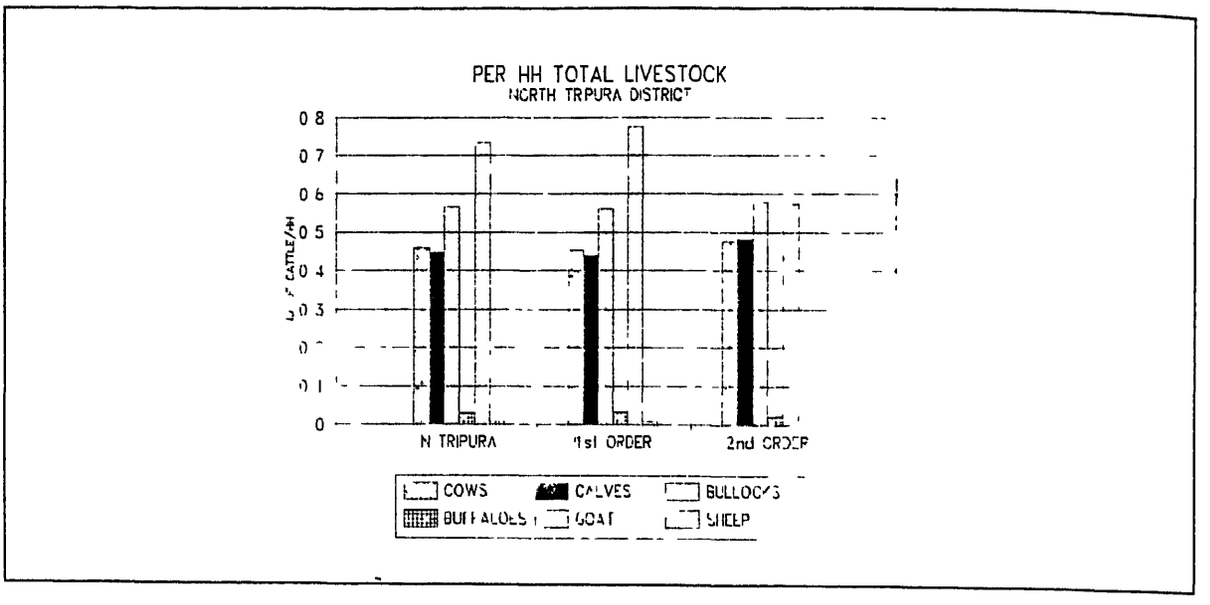
Figure 4.7 Number of pieces of land



Livestock information

The existing main cattle ownership, according to the sample survey, indicates that a household, on an average, possesses less than one head of cow 0 46 (with SD of 0 94) (Figure 4 8) Per head bullock population is slightly on the higher side accounting for 0 57 (with a SD of 1 17) Goat population is the highest amongst all the animals accounting for 0 73 per hh (with SD of 1 35) Cow is the major source of milk amongst all the cattle accounting for 0 26 liters per animal per day

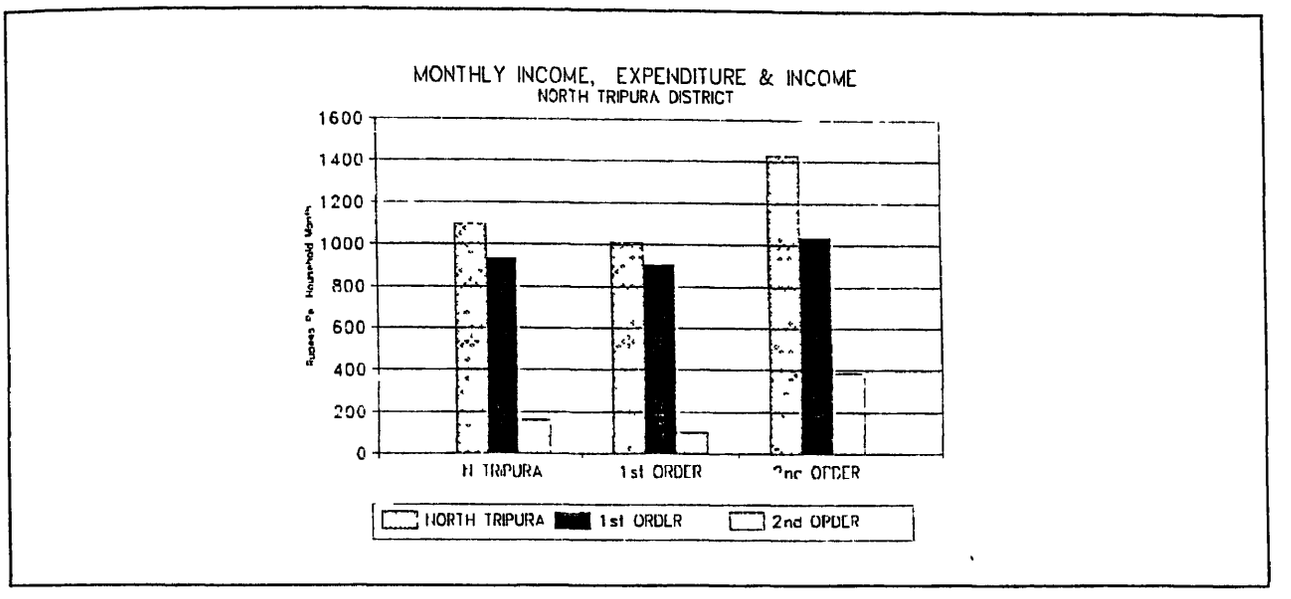
Figure 4.8 Total main livestock



Income

Income, in the context of rural communities based on subsistence agriculture outside the purview of the market systems, is a tenuous term It is difficult to estimate and the errors are high due to biased responses which tend to, in most cases, understate the income and overstate the expenditure Since income is more or less synonymous with agricultural output, and the disposable income to the surplus agricultural produce of the household, these have been the usual measures of income The estimates of the income, expenditure and the savings presented here are based on the responses As can be seen in figure no -- savings are more in the II order of settlement about Rs 391 23 compared to Rs 102 70 in the I order settlement

Figure 4.9 Per HH total income, expenditure and savings (Rs/month)



Energy resources collection and use

The implication of the abundance of biomass becomes clear when the energy consumption pattern is examined This point will be elaborated in considerable detail as the nature of biomass use and its correlation to the availability of biofuels is the key issue of rural energy planning in the district

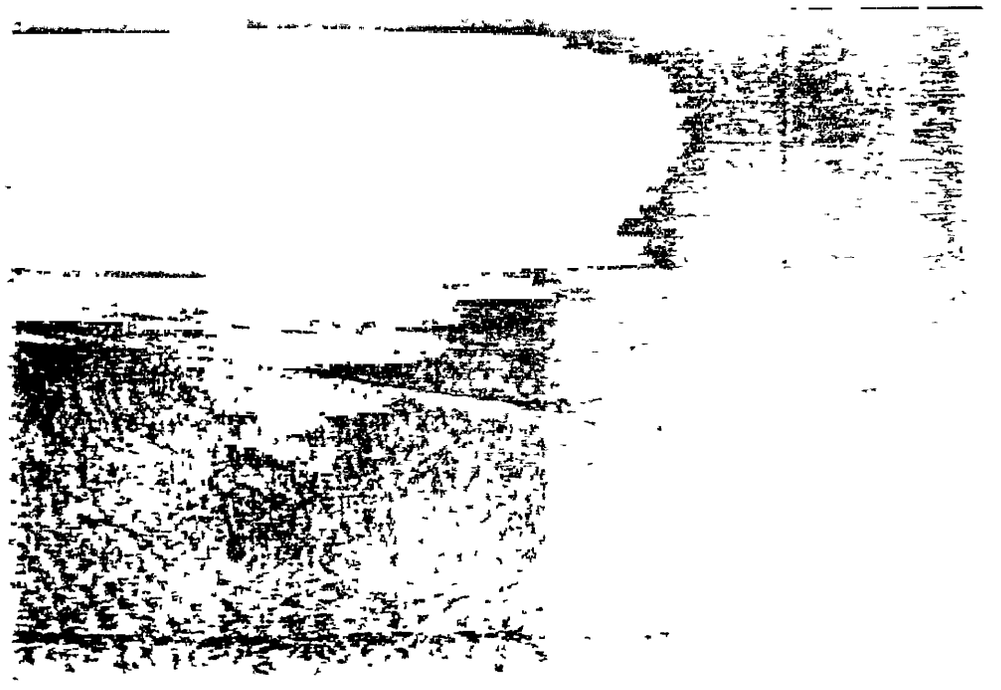
In terms of physical quantities, there is a significant variation in the average values of fuelwood use However, there is not much variation in the consumption of the I order of settlement and the II order of settlement The major difference between the two is in energy expenditure which is Rs 84 74 in the case of I order of settlement and it is Rs 35 73 in the case of II order of settlement, due to the fact that fuelwood and kerosene are purchased from the market apart from electricity As the figure 4 10 below indicates, there is not much difference in the consumption of firewood among the I order of settlement and the II order of settlement This is due to the fact that although kerosene is much accessible to the I order of settlement they do not use it for cooking since kerosene is costlier than the fuelwood As can be seen, per HH fuelwood consumption per day is 13 55 kg in I order of settlement and 13 85 kg in II order of settlement

Enduse-wise, a major proportion of fuelwood is used for cooking (11 57 kg) for cooking and for space heating (1 98 kg) per HH
per day in the I order of settlement In the case of II order settlement, fuelwood consumption for cooking is 11 94 kg and 1 91 kg for space-heating High consumption of fuelwood for space heating in the II order of settlement is due to their being surrounded by dense forest

Households with biogas plants still use traditional chulhas

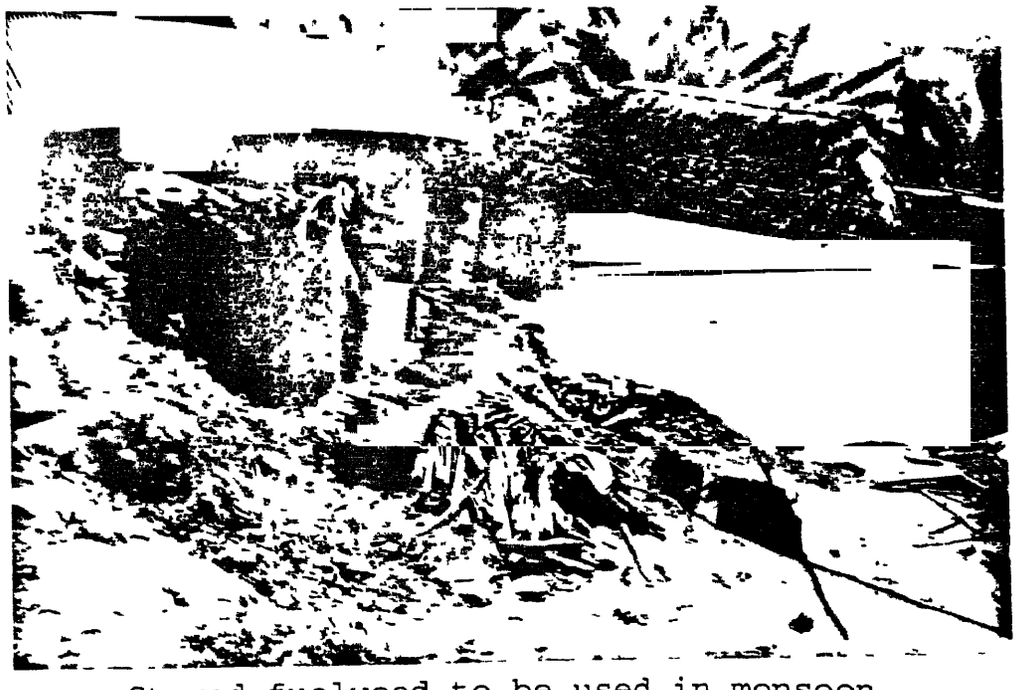
Traditional chulha of tribal family

Agrı-resıdue left for grazıng -- Block Chhamanu



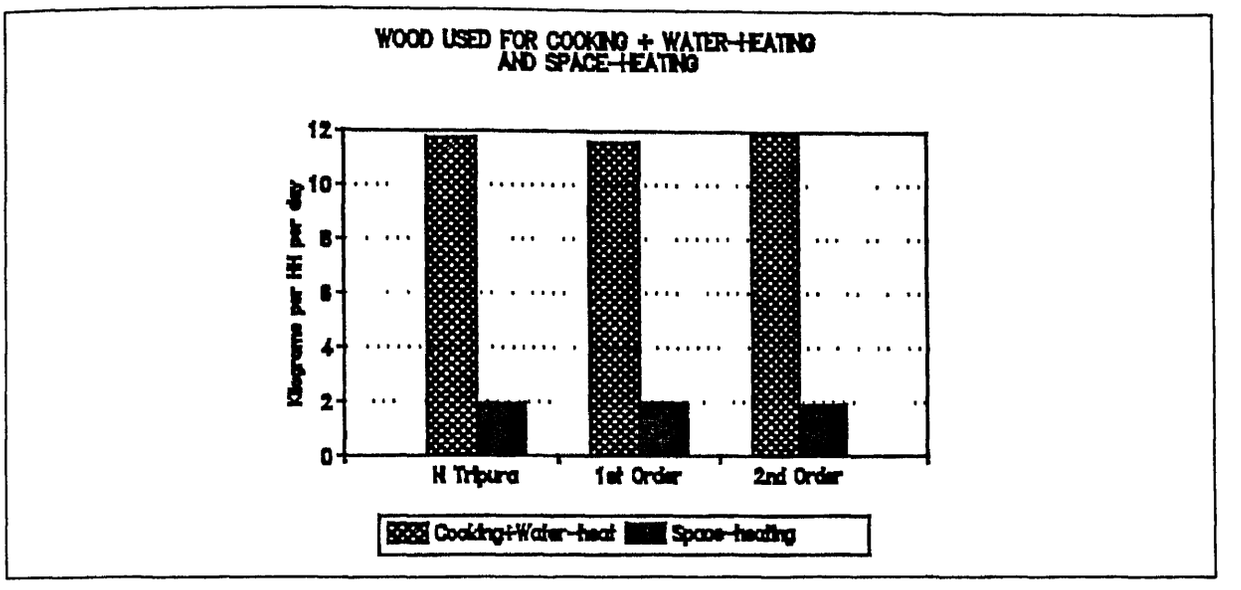
Crop resıdue left ın the fıelds to dry -- Block Salema

Women are the main collectors of fuelwood



Stored fuelwood to be used in monsoon

Figure 4.10. Total per capita wood used for cooking and waterheating



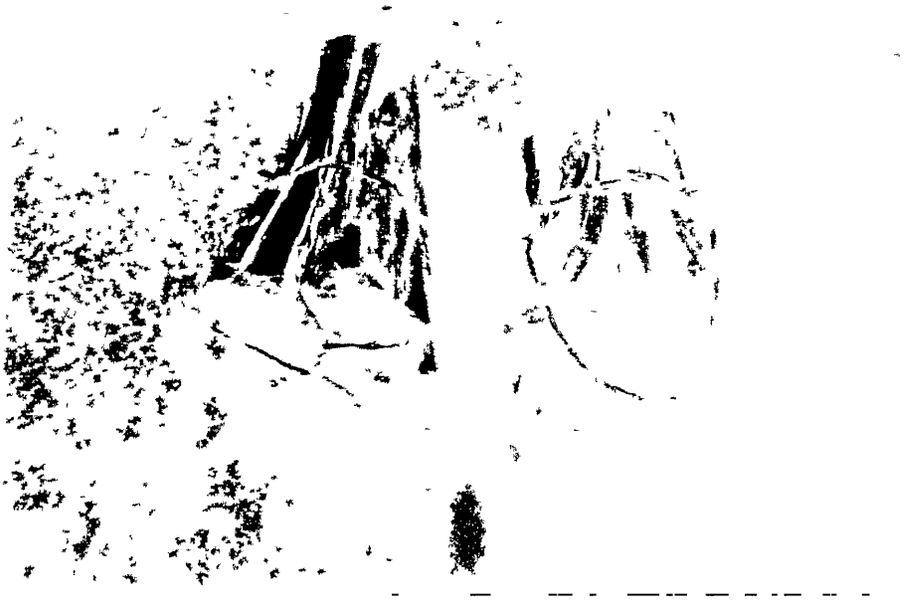
Fuelwood collection is a daily practice with almost all the HHs in North Tripura district, especially in the case of II order of settlement Average trip per HH is 0 76 (with an SD of 0 77) for wood collection Average trips per HH per week is 1 64 days (with an SD of 2 24) and average trip per day per HH is 1 25 (with a SD of 0 46) which means more than one person go for fuelwood collection per HH per day Total quantity collected at the district level is about 2 9 kg (with SD of 16 14) per day per trip per household travelling a distance of about 0 8 kilometers (SD of 1 2) per household

Animal waste

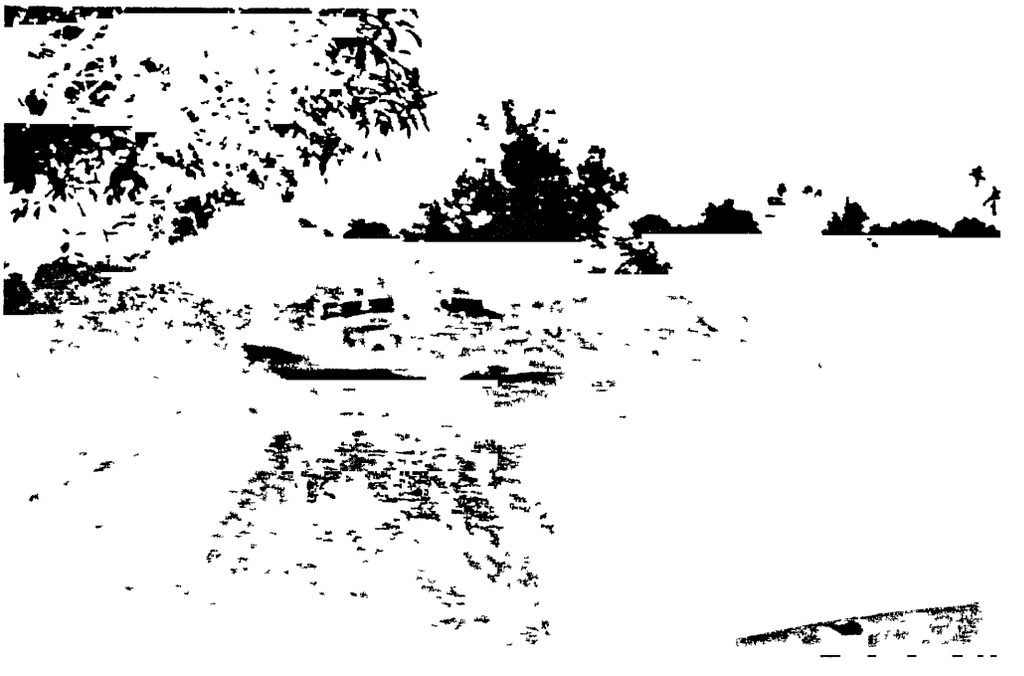
Animal waste finds little or no application as a source of energy It was pointed out earlier that the productivity of bovines in the district is low due to problems related to the availability of fodder Stall-feeding of animals is rare Consequently very little animal waste is collected There are three competing uses for animal waste -- as fuel, as farm yard manure (FYM), and for mud plastering But the major use of animal waste is in the form of farm yard manure and for mud plastering

Commercial energy sources

Except in the lighting sector, commercial energy sources play a marginal role in the present energy system of North Tripura district Electricity and kerosene are consumed mainly for lighting in both orders of settlements It has been found that only 5% of the surveyed households (with an SD of 0 5) in North Tripura district were electrified Between electricity and kerosene, the latter is more common as a lighting source The



Fuelwood headloads -- Block Salema



Timber for construction from reserve forest
Block Kanchanpur

average monthly consumption of kerosene per household is about 4 50 litres in the I order of settlement and it is 3 71 litres in the II order

Figure 4.11. Use of lighting device (hrs/day)

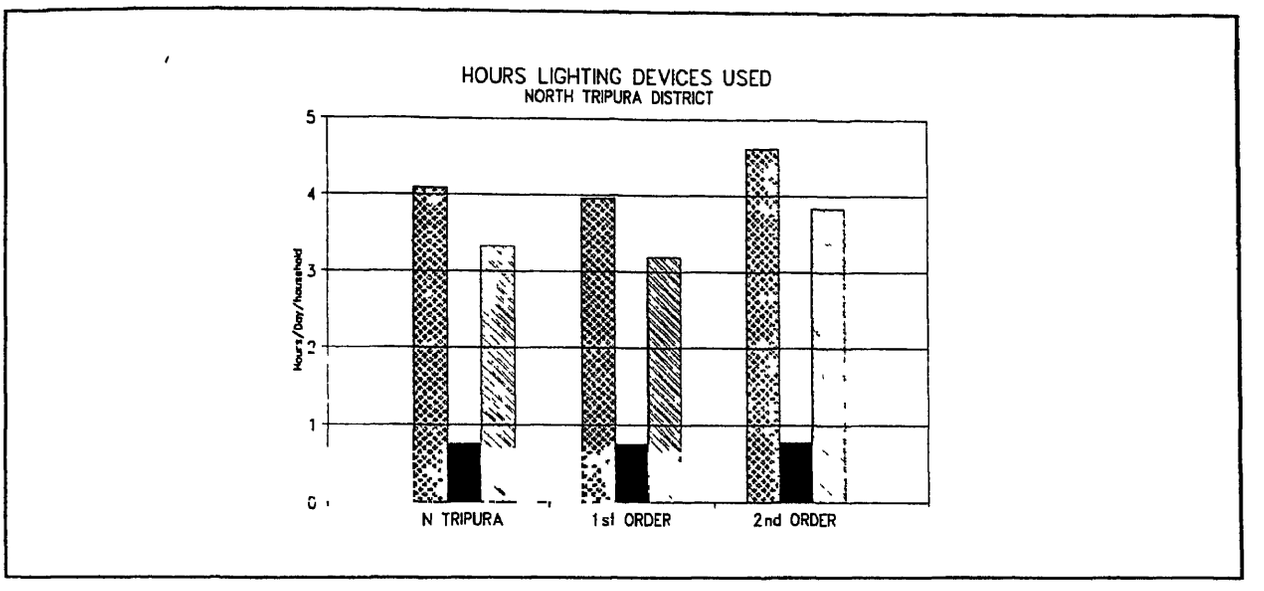
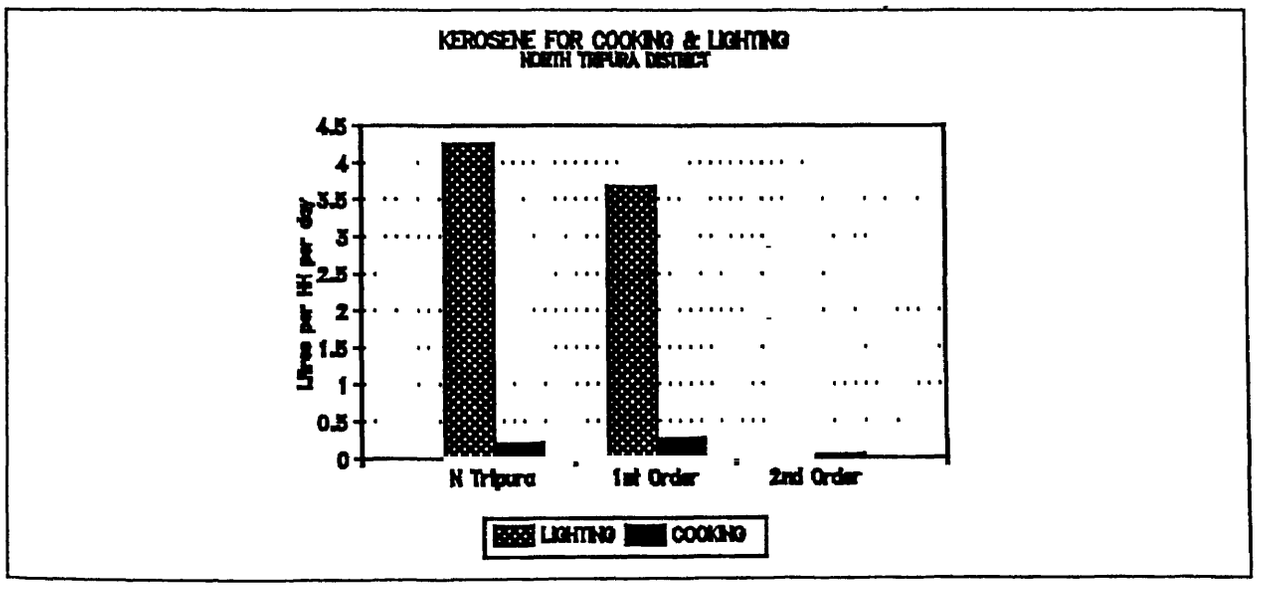


Figure 4.12 Annual kerosene consumption (litres)



Apart from electricity, *diyas* and lanterns are also used as complementary sources of lighting On an average 2.41 *diyas* are used per HH compared to 0.88 lanterns and 1 31 bulbs per HH

Energy demand

The aggregation of energy demand for North Tripura district is based on the distribution of the energy consumption pattern across different settlements. To estimate the energy demand, data collected on per capita basis for different enduses from the sample villages was used which was then aggregated for the whole district (Table No 4.4 to 4 9) Projecting energy demand requires an understanding of the factors influencing the energy demand and how these are likely to change over the time period for which the intervention is designed As a first approximation, the population is the dominant factor in the change of energy consumption over time In the tables presented, the projected energy demand reflects the changing population in the district The population projection is based on the compound growth rate till 1991

Table 4.4 Energy demand estimation - Chhamanu block

Variables	Total	I	II
Total HHs Surveyed	195	27	167
Surveyed population	1024	143	881
Total HHs (1991)	17295	1503	15792
Total HHs (2001)	22400	1946	20453
		Electricity	
Electricity consumption (1993) '000 kWh/day		0.66	6 92
Electricity demand (2001) '000 Kwh/day	9 82	0 85	8 97
		Firewood	
Cooking+waterheating (kg\hh\day)		17 89	14 69
Firewood consumption (1993) tonnes/day	259	27	232
Firewood consumption (1993) 10^9 kcal/day	1 23	0 13	1 10
Firewood demand (2001) tonnes/day	335	35	300
Firewood demand (2001) 10^9 kcal/day	1 59	0 17	1 43
Space heating (kg\hh\day)		4 38	2 92
Firewood consumption (1993) tonnes/day	53	7	46
Firewood consumption (1993) 10^9 kcal/day	0 25	0 03	0 22
Firewood demand (2001) tonnes/day	68	9	60
Firewood demand (2001) 10^9 kcal/day	0 32	04	0 28
		Kerosene	
Lighting (litres\month\hh)		4 23	2 76
kerosene consumption (1993) '000 Litres	50	6	44
Kerosene demand (2001) '000 liters	65	8	56

Table 4.5 Energy demand estimation - Kumarghat block

Variables	Sum	I	II
Total HHs surveyed	134	8	126
Surveyed population	701	40	661
Total HHs (1993)	25926	980	24946
Total HHs (2001)	33578	1270	32309
		Electricity	
Electricity consumption (1993) '000 kWh\day	8 85	0 43	8 42
Electricity Demand (2001) '000 kWh\day	11 46	0 56	10 90
		Firewood	
Cooking+waterheating (kg\day hh)		8 04	7 53
Firewood consumption (1993) tonnes/day	196	8	188
Firewood consumption (1993) 10^9 kcal/day	0 93	0 04	0 89
Firewood demand (2001) tonnes/day	254	10	243
Firewood demand (2001) 10^9 kcal/day	1 20	0 05	1 16
Space heating (kg\day\hh)		0 00	0 40
Firewood consumption (1993) tonnes/day	10	0	10
Firewood consumption (1993) 10^9 kcal/day	0 05	0 00	0 05
Firewood demand (2001) tonnes/day	13	0	13
Firewood demand (2001) 10^9 kcal/day	0 06	0 00	0 06
		Kerosene	
Lighting (litres\month\hh)		6 63	3 22
Kerosene consumption (1991) '000 litres	87	6	80
Kerosene demand (2001) '000 litres	112	8	104

Table 4.6 Energy demand estimation - Salema block

	Sum	I	II
Total HHs surveyed	143	15	128
Surveyed population	752	79	673
Total HHs (1991)	26413	1626	24787
Total HHs (2001)	34210	2106	32103
		Electricity	
Electricity consumption (1991) '000 kWh/day	9 08	0 71	8 36
Electricity demand (2001) '000 kWh/day	11 76	6 92	10 83
		Firewood	
Cooking+water heating (kg\day\hh)		13 35	13 72
Firewood consumption (1993) tonnes/day	362	22	340
Firewood consumption (1993) 10^9 kcal/day	1 72	0 10	1.62
Firewood demand (2001) tonnes/day	469	28	440
Firewood demand (2001) 10^9 kcal/day	2.23	0 13	2 09
Space heating kg\day\hh		2.53	2 66
Firewood consumption (1993) tonnes/day	70	4	66
Firewood consumption (1993) 10^9 kcal/day	0 33	0 02	0 31
Firewood demand (2001) tonnes/day	91	5	85
Firewood demand (2001) 10^9 kcal/day	0 43	0 03	0 41 6
		Kerosene	
Lighting (litres\month\hh)		3 53	4 58
Kerosene consumption (1991) '000 litres	119	6	114
Kerosene demand (2001) '000 litres	154	7	147

Table 4.7 Energy demand estimation - Kanchanpur block

Variables	North Tripura	I Order	II Order
Total HHs surveyed	182	33	149
Surveyed population	958	173	785
Total HHs (1991)	19913	4760	15153
Total HHs (2001)	25791	6165	19625
		Electricity	
Electricity consumption (1993) '000 kWh/day	7 20	2 09	5 11
Electricity demand (2001) '000 kWh/day	9 33	2 70	6 62
		Firewood	
Cooking+waterheating (kg\day\hh)		10 11	11 41
Fuelwood consumption (1993) tonnes/day	221	48	173
Fuelwood consumption (1993) 10^9 kcal/day	1 05	0 23	0 82
Fuelwood demand (2001) tonnes/day	286	62	224
Fuelwood demand (2001) 10^9 kcal/day	1 36	0 30	1 06
Space heating (kg\day\hh)		2 21	1 51
Fuelwood consumption (1993) tonnes/day	33	11	23
Fuelwood consumption (1993) 10^9 kcal/day	0 16	0 05	0 11
Fuelwood demand (2001) tonnes/day	43	14	30
Fuelwood demand (2001) 10^9 kcal/day	0 21	0 06	0 14
		Kerosene	
Lighting (litres\month\hh)		2 94	4 32
Kerosene consumption (1993) '000 tonnes	79	14	65
Kerosene demand (2001) '000 tonnes	103	18	85

Table 4.8. Energy demand estimation - Panisagar block

Variables	Sum	I	II
Total HH	72 00	9 00	63 00
Total pop	381.00	49 00	332 00
Total HH 1991	6120	342	5778
Total HH 2001	30863	1728	29135
		Electricity	
Electricity consumption (1993) '000 kWh/day	2 10	0.15	1 95
Electricity demand (2001) '000 kWh/day	2 72	0 19	2 53
		Firewood	
Cooking+waterheating (kg\day\hh)		8 48	12 34
Fuelwood consumption (1993) tonnes/day	74 23	2 90	71 33
Fuelwood consumption (1993) 10^9 kcal/day	0 35	0 01	0 34
Fuelwood demand (2001) tonnes/day	96 13	3 76	359 52
Fuelwood demand (2001) 10^9 kcal/day	0 46	0 02	0 44
Space heating (kg/day/hh)		0 78	2 08
Fuelwood consumption (1993) tonnes/day	12 28	0 27	12 01
Fuelwood consumption (1993) 10^9 kcal/day	0 058	0 001	0 057
Fuelwood demand (2001) tonnes/day	15 91	0 34	15 56
Fuelwood demand (2001) 10^9 kcal/day	0 075	0 001	0 074
		Kerosene	
Lighting (litres\month\hh)		3 89	3 47
Kerosene consumption (1993) '000 litres	21 37	1 33	20 04
Kerosene demand (2001) '000 litres	27 68	1 72	25 95

Table 4.9 Energy demand estimation - North Tripura district

Variables	North Tripura	I	II
Total HHs surveyed	726	92	633
Surveyed population	3816	484	3332
Total HHs (1993)	95668	9211	86456
Total HHs (2001)	123905	11930	111974
		Electricity	
Electricity consumption (1993) '000 kWh/day	34 81	4 04	30.77
Electricity demand (2001) in '000 kWh/day	45 08	5 23	39 85
		Fuelwood	
Cooking+waterheating		11 57	11 94
Fuelwood consumption (1993) tonnes/day	1112	108	1004
Fuelwood consumption (1993) 10^9 kcal/day	5 28	0 51	4 77
Fuelwood demand (2001) tonnes/day	1440	139	1300
Fuelwood demand (2001) 10^9 kcal/day	6 84	0 66	6 18
Space heating		1 98	1 91
Fuelwood consumption (1993) tonnes/day	178	21	157
Fuelwood consumption (1993) 10^9 kcal/day	0.85	0 10	0 74
Fuelwood demand (2001) tonnes/day	231	28	203
Fuelwood demand (2001) 10^9 kcal/day	1.10	0 13	0 96
		Kerosene	
Lighting			
Kerosene consumption (1993) '000 litres	357	34	323
Kerosene demand (2001) '000 litres	462	44	418

Table 4.10 Energy demand estimation - Salema block (Revised)

	Sum	I	II
Total HHs surveyed	143	15	128
Surveyed population	752	79	673
Total HHs (1991)	26413	4626	24787
Total HHs (2001)	37655	2318	35337
		Electricity	
Electricity consumption (1991) '000 kWh/day	9.08	0.71	8.36
Electricity demand (2001) '000 kWh/day	12 94	1 02	11.92
		Firewood	
Cooking+waterheating (kg\day\hh)		13 35	13 72
Firewood consumption (1993) tonnes/day	362	22	340
Firewood consumption (1993) 10^9 kcal/day	1.72	0 10	1.62
Firewood demand (2001) tonnes/day	516	31	485
Firewood demand (2001) 10^9 kcal/day	2.45	0 15	2.30
Space heating kg\day\hh		2.53	2 66
Firewood consumption (1993) tonnes/day	70	4	66
Firewood consumption (1993) 10^9 kcal/day	0.33	0 02	0 31
Firewood demand (2001) tonnes/day	100	6	94
Firewood demand (2001) 10^9 kcal/day	0 47	0.03	0 45
		Kerosene	
Lighting (litres\month\hh)		3.53	4.58
Kerosene consumption (1991) '000 litres	119	6	114
Kerosene demand (2001) '000 litres	170	8	162

Note Some villages of block Salema had been reformed in 1991 census which were not existent in the 1981 Census. This information was not available during the field trip in the district Therefore there are two different tables for energy demand estimation for the year 2001. Information for energy demand estimation in the first table is based on the population of old villages and in the second table (revised) energy demand estimation is computed including new formed villages.

Table 4.11 Energy demand estimation - Panisagar Block (Revised)

	Sum	I	II
Total HHs surveyed	72	9	63
Surveyed population	381	49	332
Total HHs (1991)	6120	342	5778
Total HHs (2001)	30863	1728	29135
		Electricity	
Electricity consumption (1991) '000 kWh/day	2 10	0 15	1 95
Electricity demand (2001) '000 kWh/day	10 59	0 76	9 83
		Firewood	
Cooking+waterheating (kg\day\hh)		8 48	12 34
Firewood consumption (1993) tonnes/day	74 23	2 90	71 33
Firewood consumption (1993) 10^9 kcal/day	0 35	0 01	0 34
Firewood demand (2001) tonnes/day	374 30	14 66	359 64
Firewood demand (2001) 10^9 kcal/day	1 78	0 07	1 71
Space heating kg\day\hh		0 78	2 08
Firewood consumption (1993) tonnes/day	12 28	0 27	12 01
Firewood consumption (1993) 10^9 kcal/day	0 058	0 001	0 057
Firewood demand (2001) tonnes/day	61 93	1 34	60 58
Firewood demand (2001) 10^9 kcal/day	0 294	0 006	0 288
		Kerosene	
Lighting (litres\month\hh)		3 89	3 47
Kerosene consumption (1991) '000 litres	21 37	1 33	20 04
Kerosene demand (2001) '000 litres	107 77	6 72	101 05

Note According to 1981 census for North Tripura district there were 45 villages in Panisagar block But information regarding landuse and demography for Panisagar is available only for first 31 villages Therefore energy demand estimation for the block includes population of 31 villages only Except for data on demography, village-wise landuse information was not published for the year 1991 Therefore for projecting population for the year 2001, proportional population distribution in 1st and 2nd order settlements of 1991 have taken and energy demand was estimated accordingly

Table 4.12 Energy demand estimation - North Tripura District (Revised)

	Sum	I	II
Total HHs surveyed	726	92	633
Surveyed population	3816	484	3332
Total HHs (1991)	95668	9211	86456
Total HHs (2001)	150287	13427	136859
		Electricity	
Electricity consumption (1991) '000 kWh/day	34 81	4 04	30.77
Electricity demand (2001) '000 kWh/day	54	6	48
		Firewood	
Cooking+waterheating (kg\day\hh)		11 57	11 94
Firewood consumption (1993) tonnes/day	1112	108	1004
Firewood consumption (1993) 10^9 kcal/day	5 28	0.51	4 77
Firewood demand (2001) tonnes/day	1765	153	1612
Firewood demand (2001) 10^9 kcal/day	8 38	0 73	7 66
Space heating kg\day\hh		9 89	9 57
Firewood consumption (1993) tonnes/day	178	21	157
Firewood consumption (1993) 10^9 kcal/day	0 85	0 10	0 74
Firewood demand (2001) tonnes/day	286	29	257
Firewood demand (2001) 10^9 kcal/day	1 36	0 14	1 22
		Kerosene	
Lighting (litres\month\hh)		21 21	18 35
Kerosene consumption (1991) '000 litres	357	34	323
Kerosene demand (2001) '000 litres	557	49	508

CHAPTER 5

Development priorities

Experience with various development programmes including energy intervention programmes in India has shown that the lukewarm response accorded to many of them by the people could be traced either to the lacunae in the planning and implementation, or, the divergence of perceptions among the target group of population as to what the priorities were Most of the time, there is a wide difference between the development programmes of the government and the people's priorities, one reason being that the acceptance of these programmes is critically dependent on where the felt needs of the people are placed The difference in the perceived priorities is important because this often determines the chances of success of-the programmes This is particularly true for energy development programmes and it has often been shown that several such programmes owed their non-success to the failure in taking the people's immediate needs into consideration Therefore, it is important to study the development priorities of the region so that the energy plan could be developed within the overall development strategy for the region However, before making a rural energy plan, it is also necessary to look at the priorities as perceived by both -- the government machinery which plans and implements the developmental activities, and the people who are the beneficiaries of such activities -- because of the possible difference between the two perspectives Past experience indicates that the above aspect of energy planning has not received adequate attention so far

In the present study, an attempt has been made to study the development priorities of the government as well as people's perceived needs so as to design a rural energy plan for the district, which can be integrated with the overall development plan

Development plan of the Government

Development planning process in North Tripura is decentralized as it is in any district of India Most of the development programmes fail due to their 'top to bottom' approach in which priorities are set by the officials at the higher level The lukewarm response accorded to many of these programmes by the people which can be traced either to the lacunae in the programme planning and implementation, or, the divergence of perceptions among the local people Most of the government programmes usually have an emphasis on meeting the targets which may or may not reflect the actual requirement

Based on the mandate of the Reserve Bank of India, District Credit Plan (DCP) and Service Area Credit Plan (SAC) are formulated by the district lead bank [lead bank is that national bank which has maximum number of branches in the district and the maximum number of accounts This bank is also responsible for making Annual Administrative Plans (AAPs) The lead bank for North Tripura district is the United Bank of India]. The planning process for credit disbursement through DCPs and the AAPs is governed by RBI guidelines The approach for formulating credit plans is based on the priority sector development schemes of the government where subsidy is involved.

Service Area Approach (SAA) has been introduced in the district since 1989 for the dispensation of rural credit with a view to forging an improved link between bank credit in the rural sector and increasing the production, productivity and income levels of the rural population This approach also emphasises continuous monitoring of progress in the implementation of the credit plans

The concept of SAA is to bring about a planned and orderly development of specific villages earmarked as Service Area for each bank branch A main feature of this approach is the stress given for credit planning by the bank branches at the grassroot level and their direct involvement in the development of the assigned area The basic objectives of this approach are

- Increasing productivity
- Increasing production
- Incremental benefits
- Social justice

Under this approach five distinct steps are involved, viz (i) identification of Service Area for each Bank branch, (ii) Survey of the villages in the Service Area for assessing potential of lending for different activities, (iii) Preparation of Credit Plan for the Service Area by each bank branch, (iv) Coordination between credit institutions on the one hand and the field level development agencies on the other on an on-going basis for effective implementation of credit plans, and (v) a system of continuous monitoring the progress in implementation of the plans

Governments developmental priorities for Tripura state

The major objective of the state government during the 8th Five Year Plan is to consolidate the achievements made up to the end of 1991-92 and expand the productive base of the state economy Keeping this goal in mind, the State Government adopted the following sectoral strategies for the 8th Five Year Plan (1992-97)

- To move in the direction of attaining self-sufficiency in foodgrains production and increase production and productivity in the tribal operated land.
- Extension of area under fruit crops, vegetables, spices and plantation crops with special emphasis in the ST/SC/SF/MF operated area,
- Self-sufficiency in fish production,
- To bring all the potential irrigable net cultivable area under assured irrigation.
- To cover 85% of the census villages under electrification Private sector would also be involved in power generation,
- To encourage sericulture, handloom, handicraft and small scale industries on the basis of maximum utilisation of local agricultural and forest resources Emphasis would also be given to the local production of goods of import substitutes,
- In the sphere of medium scale industries, emphasis would be given to the natural gas and rubber-based industries in the joint or private sector,
- To cover all the census villages with the supply of safe drinking water, and
- To penetrate the most remote and difficult areas with elementary education facilities and primary health services

The sector-wise break-up of the proposed outlay by the state, the recommended outlay by the Planning Commission, and the finally approved outlay for the Annual Plan 1992-93 are given in table 5 1

CHAPTER 6

Energy plan for North Tripura district

The energy consumption pattern of North Tripura district, as shown earlier, indicates that the main utilisation of energy is in the domestic sector, and fuelwood is the principal fuel for cooking and water heating. The traditional and overwhelming dependence on fuelwood which fits in with the socio-cultural milieu of the district, and its relatively easy accessibility suggests that fuelwood would continue to be the mainstay of the energy mix in the foreseeable future in the district Therefore, the energy plan envisaged for the district has to perforce base itself on promoting programmes and technologies which augment the supply as well as the efficiency of use of biomass fuels in a sustainable manner

Further, before formulating the energy plan of the district, it is important to recall the development priorities and problems requiring immediate attention as articulated by the people and as felt by the administration of the district The two, however, must be distinguished while formulating energy strategies so as to prioritize. Implementation of programmes which conform to the needs, as articulated by the people, are likely to achieve greater success while programmes reflecting the priorities of the government are more likely to receive financial support

In the energy plan presented for the district, an attempt has been made to identify regions and recommend specific interventions which are likely to yield higher dividends in these regions such as greater acceptance to technology, economies of scale in implementation due to extensive dissemination of interventions, etc In the context of energy there are two areas of focus irrigation energy requirement (mainly articulated by the people) and augmenting cooking energy supplies in selected settlements in the blocks

Energy plan

The proposed energy plan for North Tripura district considers two basic forms of technologies *recommendatory* and *demonstrative* Recommendatory technologies are those which have already been introduced in the region and are accepted by the population These technologies are, therefore, ready for immediate implementation Use of improved smokeless chulhas instead of the conventional chulhas, use of family biogas plant and cultivation of energy plantations are the recommendatory technologies considered in the energy plan of North Tripura district

Demonstrative technologies are required to be made available to the maximum number of people during their implementation It is essential to make these technologies available in well defined phases so that the necessary infrastructural network develops and sustains itself in an efficient result-oriented manner. For example, biomass gasifier, and solar photovoltaic lighting (SPV) could be introduced to the people with adequate education and social awareness who not only use them properly but also, directly or indirectly, help in educating and persuading others to use them, making the technology self-propagating Other than the above technologies, mini-micro hydel for power generation has also been discussed in the overall plan

Recommendatory technologies

Interventions in the Domestic Cooking Sector

It has been pointed out in the previous chapter that the major proportion of fuel used is wood in the domestic sector for cooking and heating The options of substituting, augmenting and conserving wood can be done by interventions of renewable energy technologies, and management of bio-resources Since the population of the district and consequently the wood consumption is rising per annum, the efficiency of devices has to be improved at household level to ensure fuelwood availability over a longer period The use of energy efficient devices will reduce the consumption of fuelwood and control the pollution created by traditional devices The traditional chulha in use is a one or two port fired clay stove without flue In most of the houses it is fixed in the kitchen with mud It is imperative that traditional and inefficient chulhas are replaced by more fuel efficient devices with a view to conserve fuelwood Improved chulhas should be used to improve health and hygienic conditions, reduce drudgery for women and children, and to improve the overall quality of life

Improved chulha (IC) consumes much less fuel than a traditional chulha (TC) The thermal efficiency of traditional chulha ranges from 8% to 12% while an IC has a range of 20% to 50% There are different designs of ICs available in India and currently, the minimum efficiency of a fixed IC is about 20% while the same for a portable IC is 25% Thus, a TC consumes 2000-2500 kg of wood per annum for an average family while the IC consumes 1000-1500 kg so almost half of the fuelwood can be saved

For dissemination of improved chulha, the methodology adopted for identifying clusters of villages with shortage of fuelwood is similar to the identification of villages as was described chapter 4

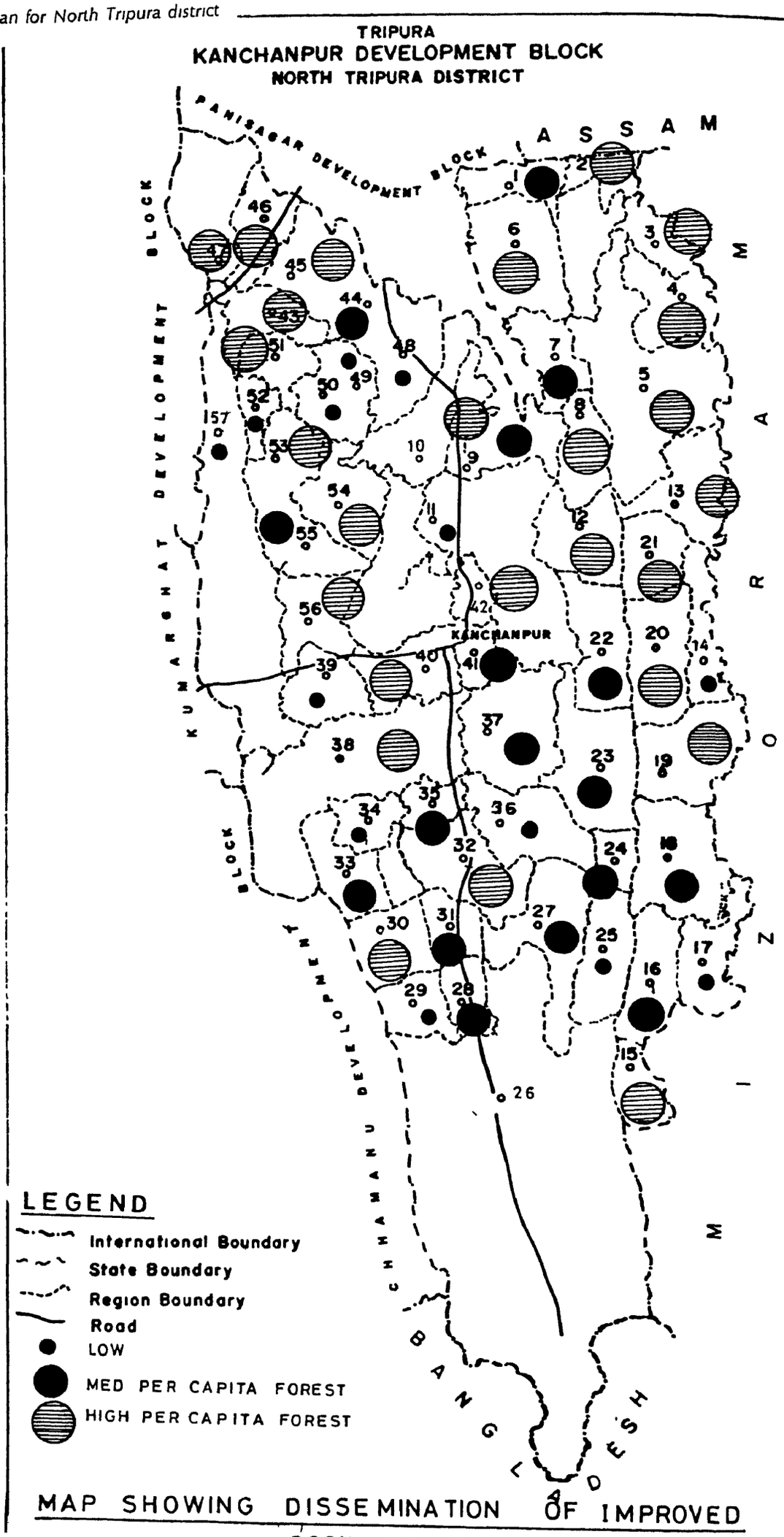
Target for cookstoves

The category-wise (per capita forest land) target for improved chulha is shown for each of the blocks in tables 6 1 to 6 5 and is based on the ultimate penetration level of 60% of the total number of households by the end of year 2001 The year-wise break-up of the targets for the cluster is uniform in terms of the fraction of the total that is to be constructed 5% in 1st and 7th year, with the remaining 50% equally distributed between rest of the five years of the programme for all the five blocks respectively. First phase of the programme can be initiated in those villages which have low per capita forest land and then subsequently in the villages with medium per capita, and in the last, in villages with high per capita forest land.

Table 6.1. Target and phasing of cookstoves programme in Kanchanpur block

Sl No	Location		Total HH	Total target							
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
				Villages having low per capita forest							
1	212141	Kanchanpur	2332	1399	117	233	233	233	233	233	117
2	212130	Sunitipur	137	82	7	14	14	14	14	14	7
3	212110	Lilijuri	912	547	46	91	91	91	91	91	46
4	212152	Dhanichhara	988	593	49	99	99	99	99	99	49
5	212142	Santipur	282	169	14	28	28	28	28	28	14
6	212153	Uttar Machmara	1462	877	73	146	146	146	146	146	73
7	212148	Pencharthal	1154	692	58	115	115	115	115	115	58
8	212111	Sibnagar	563	338	28	56	56	56	56	56	28
9	212136	Dasda Laxmipur	1821	1093	91	182	182	182	182	182	91
10	21212	Damchhara	496	298	25	50	50	50	50	50	25
11	212151	Nalkata	608	365	30	61	61	61	61	61	30
12	212137	Satnala	1747	1048	87	175	175	175	175	175	87
				Villages having medium per capita forest							
13	212140	Kanchanchhara	552	331	28	55	55	55	55	55	28
14	212155	Dakhin Machmara	509	306	25	51	51	51	51	51	25
15	212145	Laxman Chhara	442	265	22	44	44	44	44	44	22
16	212129	Kalapania	237	142	12	24	24	24	24	24	12
17	212144	Nabinchhara	214	128	11	21	21	21	21	21	11
18	212132	Tuichhama	756	453	38	76	76	76	76	76	38
19	212113	Khedachhara	684	410	34	68	68	68	68	68	34
20	212149	Karaichhara	174	105	9	17	17	17	17	17	9
21	21211	Rahum Chhara	269	161	13	27	27	27	27	27	13
22	212127	Gachirampara	490	294	24	49	49	49	49	49	24
23	212115	Contral Catchment R F	289	174	14	29	29	29	29	29	14
24	212150	Baghaichhara	330	198	16	33	33	33	33	33	16
25	212114	Kalagang	98	59	5	10	10	10	10	10	5
26	212154	Dewenbari	211	126	11	21	21	21	21	21	11
27	212135	Kamarmara	111	67	6	11	11	11	11	11	6
28	212147	Paschim Andharchhara	167	100	8	17	17	17	17	17	8
29	21213	Narendranagar	341	205	17	34	34	34	34	34	17

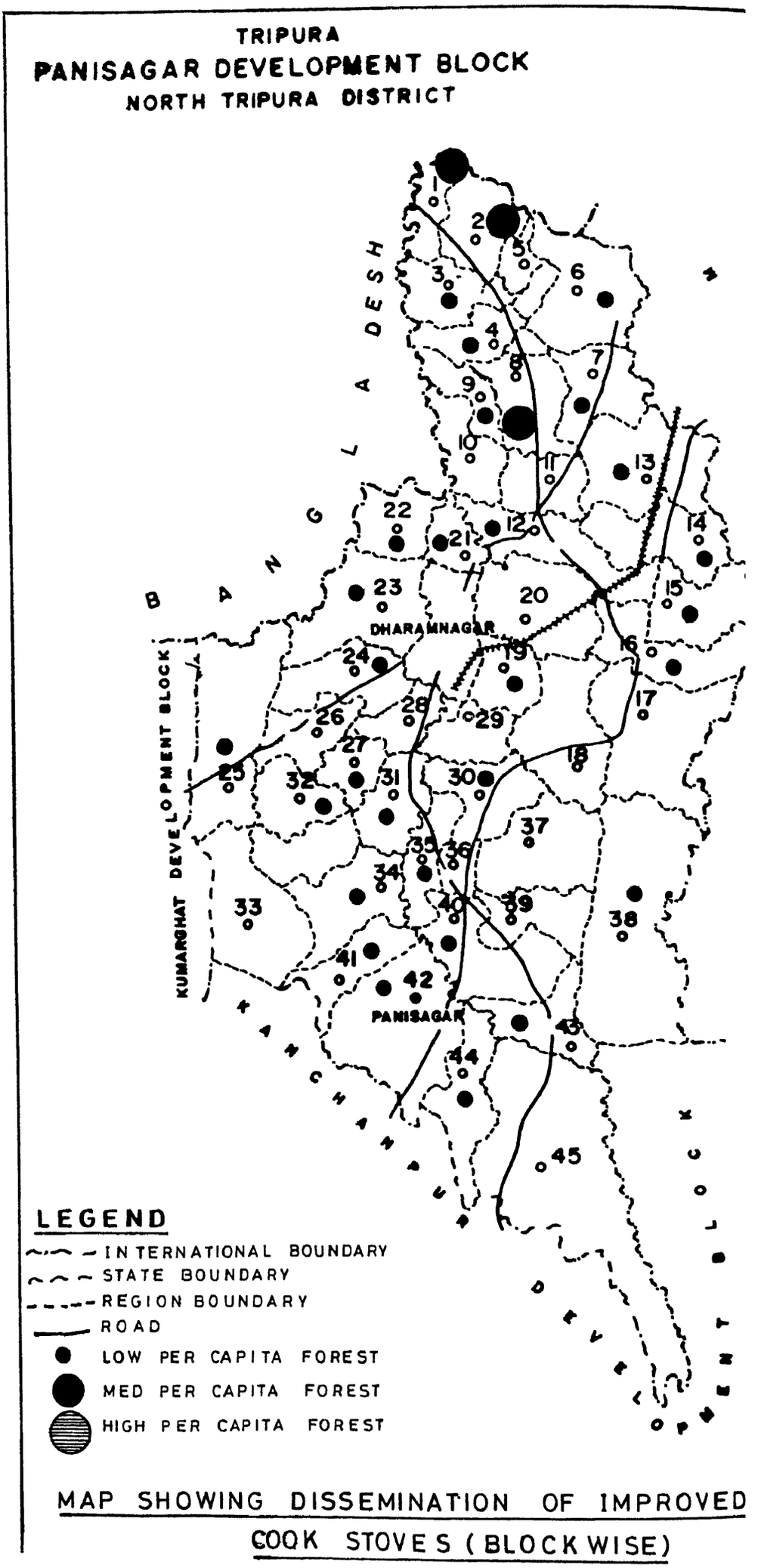
Sl No	Location		Total HH	Total target							
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
30	212146	Purba Andharchhara	444	266	22	44	44	44	44	44	22
31	212122	Paschim Manpai	177	106	9	18	18	18	18	18	9
				Villages having high per capita forest							
32	212139	Chandipur	135	81	7	13	13	13	13	13	7
33	212116	Sabual	189	114	9	19	19	19	19	19	9
34	212123	Belianchief	264	159	13	26	26	26	26	26	13
35	21217	Bangsul	187	112	9	19	19	19	19	19	9
36	21214	Kacharichhara	254	152	13	25	25	25	25	25	13
37	21216	Pipla Chhara	295	177	15	30	30	30	30	30	15
38	21219	Ujan Machmara R F	1022	613	51	102	102	102	102	102	51
39	212118	Simblong	161	97	8	16	16	16	16	16	8
40	212121	Purba Manpai	148	89	7	15	15	15	15	15	7
41	212119	Bhangmun	217	130	11	22	22	22	22	22	11
42	212133	Teiyang para	67	40	3	7	7	7	7	7	3
43	212126	Central Catchment R F	1911	1146	95	191	191	191	191	191	95
44	212134	Dasamanipara	38	23	2	4	4	4	4	4	2
45	212125	Paschim Tlangsanbari	219	131	11	22	22	22	22	22	11
46	212112	Jamaraipara	186	112	9	19	19	19	19	19	9
47	212131	Ramprasaoipara	73	44	4	7	7	7	7	7	4
48	212138	Manu chailengta R F	319	192	16	32	32	32	32	32	16
49	212156	Rabiraipara	141	84	7	14	14	14	14	14	7
50	212117	Salio	55	33	3	5	5	5	5	5	3
51	212128	Lambachhara	52	31	3	5	5	5	5	5	3
52	212124	Banglabari	40	24	2	4	4	4	4	4	2
53	212143	Birchandranagar	121	72	6	12	12	12	12	12	6
54	21215	Damchhara R F	272	163	14	27	27	27	27	27	14
55	212157	Deo Reserve Forest	307	184	15	31	31	31	31	31	15
56	21218	Jayantipara	60	36	3	6	6	6	6	6	3
57	212120	Tlakchi	62	37	3	6	6	6	6	6	3



MAP SHOWING DISSEMINATION OF IMPROVED COOK STOVES (BLOCK WISE)

Table 6.2 Target and phasing of cookstoves for Panisagar Block

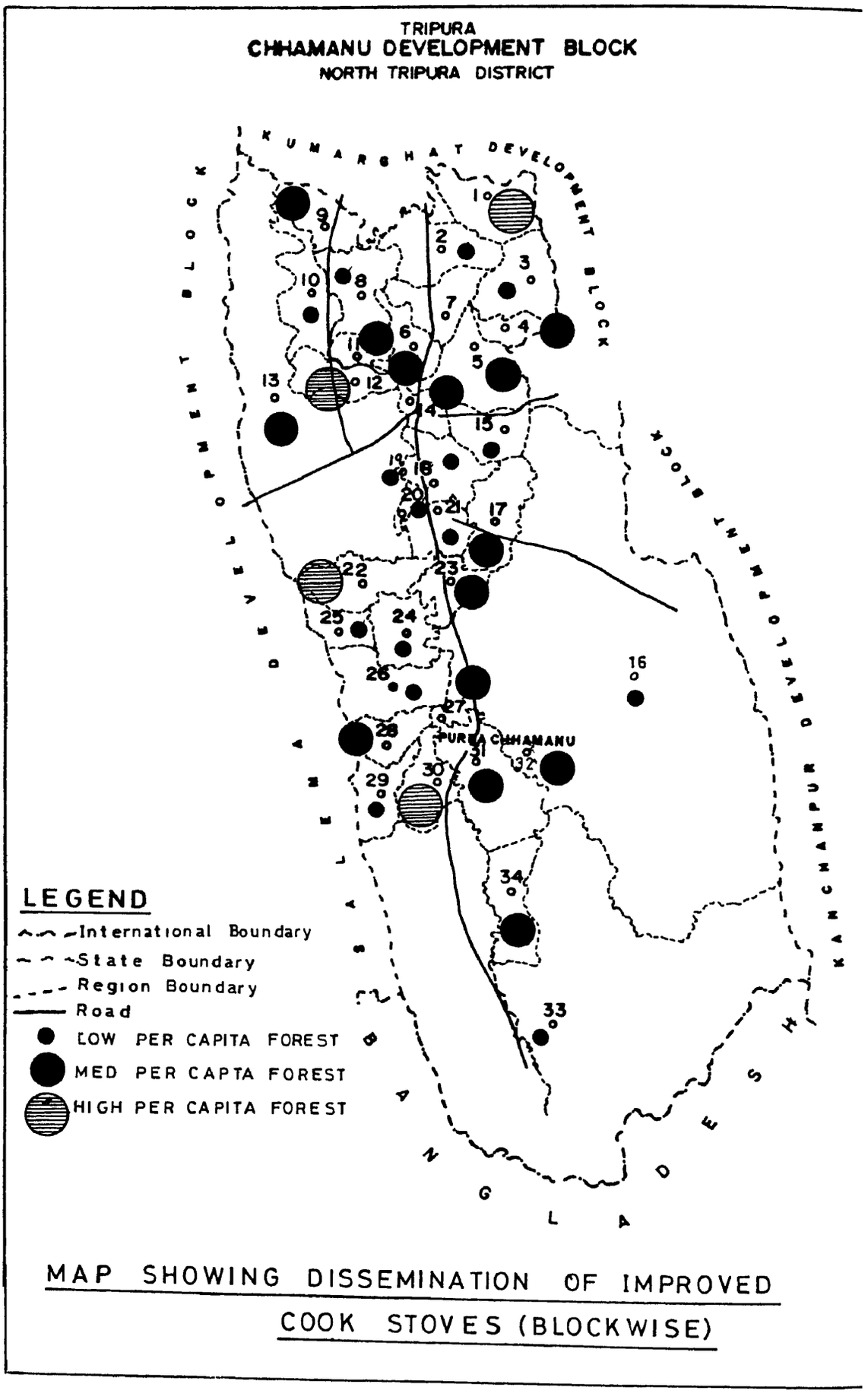
Sl No	Location		Total HH	Total target						
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
				Villages having low per capita forest							
1	212220	Hurua	2247	1348	112	225	225	225	225	225	112
2	212221	Bhagyapur	641	385	32	64	64	64	64	64	32
3	212219	Kameswar	1752	1051	88	175	175	175	175	175	88
4	212212	Pratyekrai	1568	941	78	157	157	157	157	157	78
5	212218	Ganganagar	1167	700	58	117	117	117	117	117	58
6	212222	Ragna	564	339	28	56	56	56	56	56	28
7	212229	Dhupirband	1172	703	59	117	117	117	117	117	59
8	212230	Uptakhali	882	529	44	88	88	88	88	88	44
9	212228	Radhapur	663	398	33	66	66	66	66	66	33
10	212223	Baruakandi	2687	1612	134	269	269	269	269	269	134
11	212227	Purba Halflong	427	256	21	43	43	43	43	43	21
12	21227	Kadamtala	1807	1084	90	181	181	181	181	181	90
13	21229	Maheshpur	480	288	24	48	48	48	48	48	24
14	21225	Piarachhara	361	217	18	36	36	36	36	36	18
15	21226	Kurti	2099	1259	105	210	210	210	210	210	105
16	212210	Bishnupur	915	549	46	92	92	92	92	92	46
17	212211	Ichailalchhara	721	432	36	72	72	72	72	72	36
18	21228	Saraspur	1365	819	68	136	136	136	136	136	68
19	21221	Satsangam	607	364	30	61	61	61	61	61	30
20	21223	Brajendranagar	658	395	33	66	66	66	66	66	33
21	21224	Sarala	327	196	16	33	33	33	33	33	16
22	212224	Dewanpasa	1639	983	82	164	164	164	164	164	82
23	21222	Ranibari	334	200	17	33	33	33	33	33	17
24	212213	Churaibari	2329	1398	116	233	233	233	233	233	116
25	212216	Sanichhara	618	371	31	62	62	62	62	62	31
26	212231	Jubarajnagar	764	459	38	76	76	76	76	76	38
27	212214	Laxminagar	655	393	33	65	65	65	65	65	33
28	212226	Paschim Halflong	412	247	21	41	41	41	41	41	21
				Villages with medium per capita forest							
29	212217	Bagbasa	521	312	26	52	52	52	52	52	26
30	212225	Balidhum	254	152	13	25	25	25	25	25	13
31	212215	Chandpur	227	136	11	23	23	23	23	23	11



MAP SHOWING DISSEMINATION OF IMPROVED COOK STOVES (BLOCKWISE)

Table 6.3. Target and phasing of cookstoves for Chhamanu Block

Sl No	Location		Total HH	Total target							
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
				Villages with low per capita forest							
1	212320	Gainarma	338	203	17	34	34	34	34	34	17
2	212321	Chhailengta	991	594	50	99	99	99	99	99	50
3	212319	Jamirchhara	200	120	10	20	20	20	20	20	10
4	212318	Mainama	1202	721	60	120	120	120	120	120	60
5	21235	Purba Masli	916	550	46	92	92	92	92	92	46
6	212332	Manikpur	332	199	17	33	33	33	33	33	17
7	21237	Paschim Karamchhara	805	483	40	81	81	81	81	81	40
8	212327	Makarchhara	259	155	13	26	26	26	26	26	13
9	212314	Manu	956	573	48	96	96	96	96	96	48
10	212311	Uttar Dhumachhara	699	419	35	70	70	70	70	70	35
11	212317	Lalchhara	940	564	47	94	94	94	94	94	47
12	212312	Dakshin Dhumachhara	962	577	48	96	96	96	96	96	48
13	212330	Paschim Chhamanu	654	392	33	65	65	65	65	65	33
14	21236	Paschim Masli	553	332	28	55	55	55	55	55	28
				Villages with medium per capita forest							
15	21239	Kathalchhara	909	545	45	91	91	91	91	91	45
16	21234	Purba Karamchhara	308	185	15	31	31	31	31	31	15
17	212323	Durgachhara	477	286	24	48	48	48	48	48	24
18	21238	Karatichhara	666	400	33	67	67	67	67	67	33
19	212310	Demchhara	431	259	22	43	43	43	43	43	22
20	212328	Uttar Longtarai	211	126	11	21	21	21	21	21	11
21	21231	Kanchanchhara	614	368	31	61	61	61	61	61	31
22	21232	Nalkata	799	479	40	80	80	80	80	80	40
23	212315	Jarulchhara	261	157	13	26	26	26	26	26	13
24	212324	Sonapur	338	203	17	34	34	34	34	34	17
25	21233	Ultachhara	240	144	12	24	24	24	24	24	12
26	212313	Longtarai R F	2086	1251	104	208	208	208	208	208	104
27	212322	Ghagrachhara	268	161	13	27	27	27	27	27	13
28	212334	Debchhara	74	44	4	7	7	7	7	7	4
29	212329	Dakshin Longtarai	128	77	6	13	13	13	13	13	6
30	212331	Purba Chhamanu	307	184	15	31	31	31	31	31	15
				Villages with high per capita forest							
31	212326	Sadhujanpur	126	75	6	13	13	13	13	13	6
32	212333	Central Catchment R F	1941	1165	97	194	194	194	194	194	97
33	212316	Manu Chailengta R F	1371	823	69	137	137	137	137	137	69
34	212325	Joy Chandra Para	49	29	2	5	5	5	5	5	2

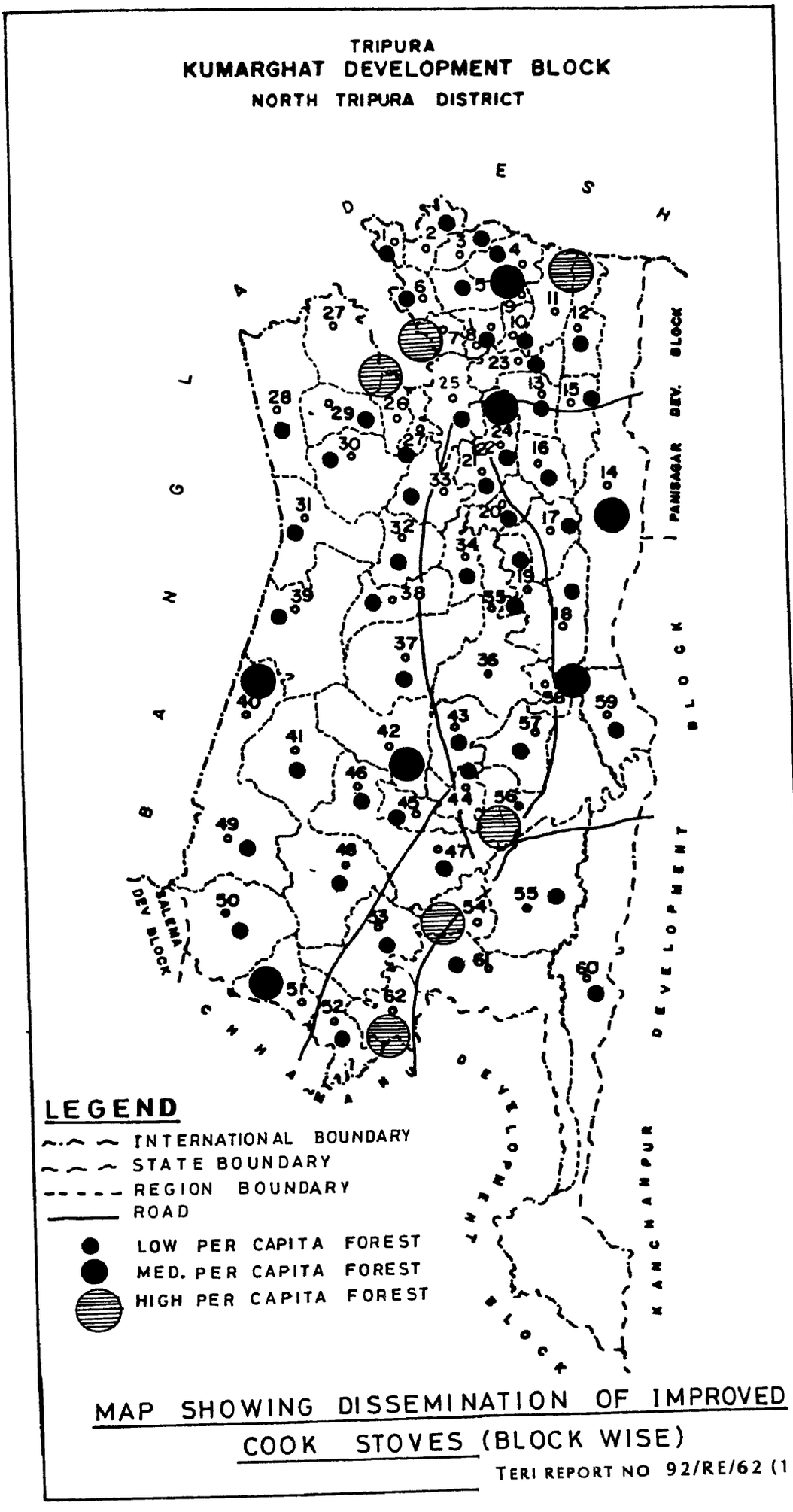


MAP SHOWING DISSEMINATION OF IMPROVED COOK STOVES (BLOCKWISE)

Table 6.4 Target and phasing of cookstoves programme for Kumarghat Block

Sl No	Location		Total HH	Total target							
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
				Villages with low per capita forest							
1	21241	Srirampur	760	456	38	76	76	76	76	76	38
2	21242	Chandipur	519	312	26	52	52	52	52	52	26
3	21243	Chantail	650	390	32	65	65	65	65	65	32
4	21245	Guldharpur	485	291	24	48	48	48	48	48	24
5	21246	Kamrangabari	325	195	16	33	33	33	33	33	16
6	21247	Gournagar	357	214	18	36	36	36	36	36	18
7	21248	Ichabpur	564	339	28	56	56	56	56	56	28
8	21249	Krishnanagar	760	456	38	76	76	76	76	76	38
9	212410	Fatikroy	1026	616	51	103	103	103	103	103	51
10	212412	Gakulnagar	574	345	29	57	57	57	57	57	29
11	212413	Fultali	649	389	32	65	65	65	65	65	32
12	212415	Birchandranagar	629	377	31	63	63	63	63	63	31
13	212416	Bilashpur	575	345	29	58	58	58	58	58	29
14	212419	Dhanbilash	938	563	47	94	94	94	94	94	47
15	212420	Kaulikura	367	220	18	37	37	37	37	37	18
16	212421	Laxmipur	497	298	25	50	50	50	50	50	25
17	212422	Tilagaon	466	280	23	47	47	47	47	47	23
18	212423	Jubarajnagar	657	394	33	66	66	66	66	66	33
19	212424	Kanakpur	364	219	18	36	36	36	36	36	18
20	212425	Rangauti	542	325	27	54	54	54	54	54	27
21	212426	Latiapur	231	139	12	23	23	23	23	23	12
22	212427	Dhaliarkandi	1156	693	58	116	116	116	116	116	58
23	212430	Khowrabil	267	160	13	27	27	27	27	27	13
24	212431	Srinathpur	486	291	24	49	49	49	49	49	24
25	212432	Natingchhara	104	62	5	10	10	10	10	10	5
26	212433	Masauli	902	541	45	90	90	90	90	90	45
27	212434	Paschim Kanchanbari	1578	947	79	158	158	158	158	158	79
28	212435	Kumarghat	0	0	0	0	0	0	0	0	0
29	212436	Samrurpar	834	501	42	83	83	83	83	83	42
30	212437	Purba Ratachhara	1168	701	58	117	117	117	117	117	58
31	212438	Sonaimuri	665	399	33	66	66	66	66	66	33
32	212439	Dudhpur	974	584	49	97	97	97	97	97	49
33	212442	Pabiachhara	244	146	12	24	24	24	24	24	12

Sl No	Location		Total HH	Total target						
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
34	212443	Jalai	478	287	24	48	48	48	48	48	24
35	212444	Jarultali	460	276	23	46	46	46	46	46	23
36	212445	Rangrung	661	396	33	66	66	66	66	66	33
37	212446	Jagannathpur	595	357	30	59	59	59	59	59	30
38	212447	Paschim Ratachhara	880	528	44	88	88	88	88	88	44
39	212448	Purba Kanchanbari	550	330	27	55	55	55	55	55	27
40	212451	Radhanagar	1073	644	54	107	107	107	107	107	54
41	212452	Debasthal	255	153	13	25	25	25	25	25	13
42	212453	Golakpur	507	304	25	51	51	51	51	51	25
43	212454	Bhagabannagar	622	373	31	62	62	62	62	62	31
44	212455	Laljuri	391	235	20	39	39	39	39	39	20
45	212456	Deorachhara	510	306	25	51	51	51	51	51	25
46	212457	Pakhirbada	315	189	16	32	32	32	32	32	16
47	212458	Halaichhara	248	149	12	25	25	25	25	25	12
48	212461	Betchhara	776	466	39	78	78	78	78	78	39
49	212462	Ganganagar	463	278	23	46	46	46	46	46	23
				Villages with medium per capita forest							
50	212411	Manu Valley	401	241	20	40	40	40	40	40	20
51	212417	Hirachhara	207	124	10	21	21	21	21	21	10
52	212418	Sonamukhi	466	280	23	47	47	47	47	47	23
53	212428	Rajkandi	464	278	23	46	46	46	46	46	23
54	212429	Murtichhara	328	197	16	33	33	33	33	33	16
55	212441	Dengdung	308	185	15	31	31	31	31	31	15
56	212450	Dhatuchhara	128	77	6	13	13	13	13	13	6
				Villages with high per capita forest							
57	21244	Saydachhara	197	118	10	20	20	20	20	20	10
58	212414	Deo Reserve Forest	829	497	41	83	83	83	83	83	41
59	212440	Irani	752	451	38	75	75	75	75	75	38
60	212449	Dakshin Unakuti R F	145	87	7	14	14	14	14	14	7
61	212459	Uttar Unakuti R.F	224	134	11	22	22	22	22	22	11
62	212460	Samruhala R.F	33	20	2	3	3	3	3	3	2



MAP SHOWING DISSEMINATION OF IMPROVED COOK STOVES (BLOCK WISE)

TERI REPORT NO 92/RE/62 (1994)

Table 6.5. Target and phasing of cookstoves programme for Salema Block

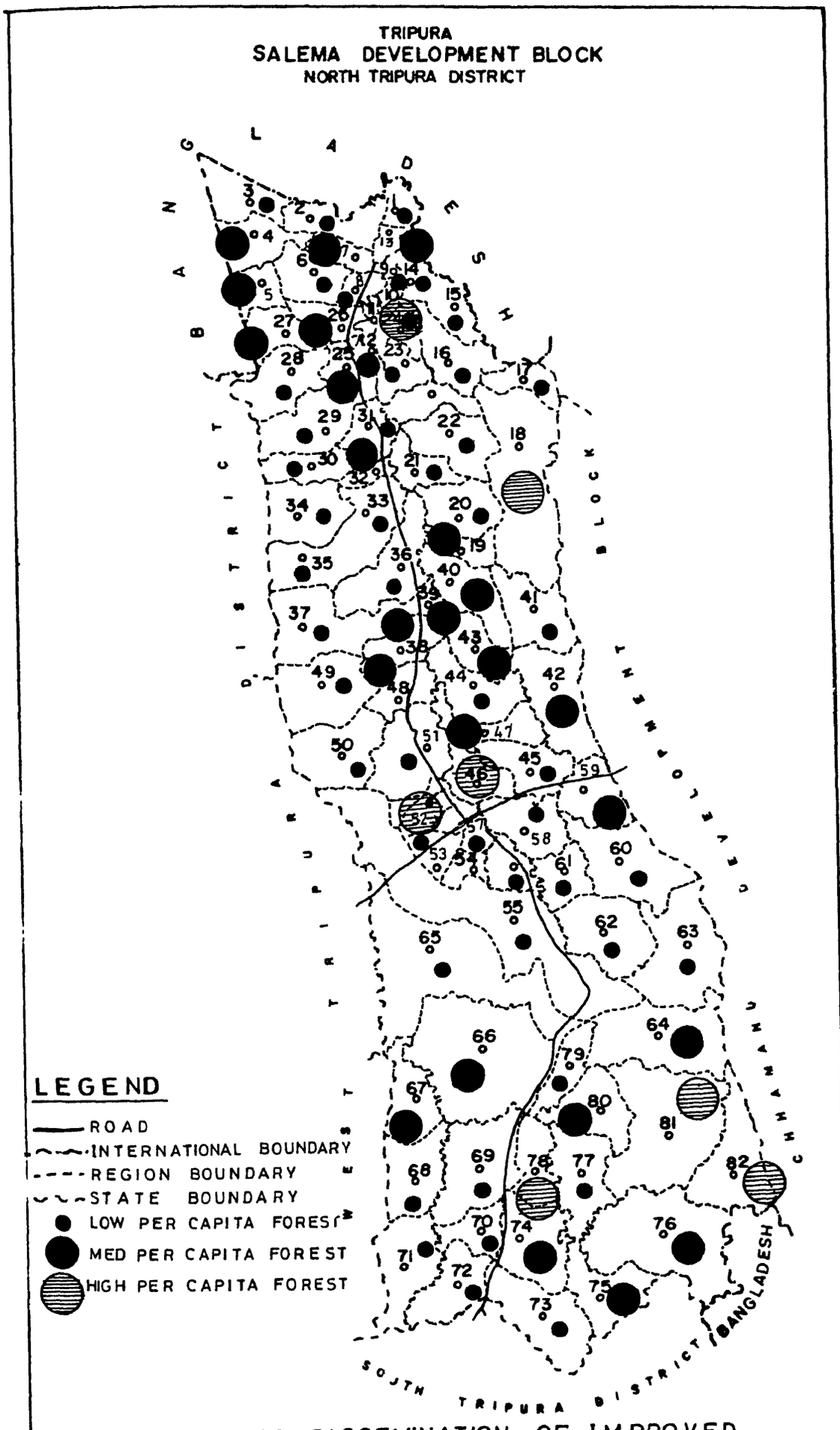
Sl No	Location		Total HH	Total target							
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
				Villages with low per capita forest							
1	212524	Chulubari	811	487	41	81	81	81	81	81	41
2	212525	Manikbhander	1015	609	51	101	101	101	101	101	51
3	212526	Kalachhari	950	570	47	95	95	95	95	95	47
4	212523	Bamanchhara	606	364	30	61	61	61	61	61	30
5	212519	Jamthumbari	326	196	16	33	33	33	33	33	16
6	212521	Debichhara	726	436	36	73	73	73	73	73	36
7	212522	Mahabir	787	472	39	79	79	79	79	79	39
8	212533	Baraluthma	607	364	30	61	61	61	61	61	30
9	212551	Purba Nalichhara	1721	1032	86	172	172	172	172	172	86
10	212548	Purba Daluchhara	997	598	50	100	100	100	100	100	50
11	212532	Nakful	339	203	17	34	34	34	34	34	17
12	212527	Lembuchhara	589	353	29	59	59	59	59	59	29
13	212528	Srirampur	292	175	15	29	29	29	29	29	15
14	212529	Duraichhara	624	375	31	62	62	62	62	62	31
15	212518	Longtarai R F	123	74	6	12	12	12	12	12	6
16	212512	Darangtila	183	110	9	18	18	18	18	18	9
17	212513	Kuchainala	565	339	28	56	56	56	56	56	28
18	212511	Mathirmia	259	155	13	26	26	26	26	26	13
19	21259	Halhali	127	76	6	13	13	13	13	13	6
20	212510	Panchasi	257	154	13	26	26	26	26	26	13
21	21251	Mohanpur	414	248	21	41	41	41	41	41	21
22	212517	Chhetrai	113	68	6	11	11	11	11	11	6
23	212516	Chotasurma	925	555	46	92	92	92	92	92	46
24	212514	Barasurma	429	258	21	43	43	43	43	43	21
25	212531	Halhali	1191	714	60	119	119	119	119	119	60
26	21257	Noagaon	875	525	44	87	87	87	87	87	44
27	21258	Harerkhola	863	518	43	86	86	86	86	86	43
28	212558	Ambasa	1083	650	54	108	108	108	108	108	54
29	212515	Marachhara	570	342	29	57	57	57	57	57	29
30	212560	Sikaribari	406	244	20	41	41	41	41	41	20
31	212557	Kanchanpur	1485	891	74	148	148	148	148	148	74
32	21252	Ganganagar	832	499	42	83	83	83	83	83	42
33	212520	Chankap	630	378	31	63	63	63	63	63	31
34	212538	Salema	837	502	42	84	84	84	84	84	42
35	212544	Kachuchara	967	580	48	97	97	97	97	97	48

Sl No	Location		Total HH	Total target							
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
36	212559	Kathalbari	416	250	21	42	42	42	42	42	21
37	212552	Kulai	767	460	38	77	77	77	77	77	38
38	212571	Pustarai Para	195	117	10	19	19	19	19	19	10
39	212543	Debbari	330	198	17	33	33	33	33	33	17
40	212562	Harimangalpara	152	91	8	15	15	15	15	15	8
41	21256	Mayachhari	599	359	30	60	60	60	60	60	30
42	212553	Kamalachhara	487	292	24	49	49	49	49	49	24
43	212546	Lalchhari	641	385	32	64	64	64	64	64	32
44	212536	Abhanga	1046	628	52	105	105	105	105	105	52
45	212570	Radharambari	56	34	3	6	6	6	6	6	3
46	212540	Michhuria	540	324	27	54	54	54	54	54	27
47	212547	Balaram	496	298	25	50	50	50	50	50	25
48	212554	Raipasa	214	128	11	21	21	21	21	21	11
49	212539	Maharani	222	133	11	22	22	22	22	22	11
50	212530	Apareshkar	415	249	21	42	42	42	42	42	21
				Villages with medium per capita forest							
51	212581	Tetaiya	199	119	10	20	20	20	20	20	10
52	212535	Kataluthma	834	501	42	83	83	83	83	83	42
53	212582	Chakma Para	360	216	18	36	36	36	36	36	18
54	212576	Siddha Para	216	130	11	22	22	22	22	22	11
55	212580	Lalchhara	148	89	7	15	15	15	15	15	7
56	212567	Karaibari (Karmapara)	190	114	9	19	19	19	19	19	9
57	212556	Jagannathpur	317	190	16	32	32	32	32	32	16
58	212575	Satbhaiya Para	91	55	5	9	9	9	9	9	5
59	212534	Panbua	366	220	18	37	37	37	37	37	18
60	212561	Auliraipara	108	65	5	11	11	11	11	11	5
61	212545	Bagmara	344	207	17	34	34	34	34	34	17
62	212537	Mendi	595	357	30	59	59	59	59	59	30
63	212550	Paschim Nalichhara	295	177	15	29	29	29	29	29	15
64	212569	Ganganagar	775	465	39	77	77	77	77	77	39
65	212577	Khamu Para	93	56	5	9	9	9	9	9	5
66	212549	Paschim Daluchhara	324	195	16	32	32	32	32	32	16
67	212565	Kulai R.F (Ext)	417	250	21	42	42	42	42	42	21
68	212563	Gurudhan Para	250	150	12	25	25	25	25	25	12
69	212564	Baluchhara	105	63	5	10	10	10	10	10	5

Sl No	Location		Total HH	Total target						
	Code No	Name of Village		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
70	212573	Dangama Para	79	47	4	8	8	8	8	8	4
71	21255	Bishnupur	123	74	6	12	12	12	12	12	6
72	212579	Karnamunipara	79	47	4	8	8	8	8	8	4
73	212578	Khowaipar	105	63	5	10	10	10	10	10	5
74	212574	Gangaprasad Para	40	24	2	4	4	4	4	4	2
75	212572	Sardinkha Para	48	29	2	5	5	5	5	5	2
				Villages with high per capita forest							
76	212566	Ulemchhara	105	63	5	10	10	10	10	10	5
77	21253	Uttar Bilash Chhara	82	49	4	8	8	8	8	8	4
78	212541	Simbuchak	104	62	5	10	10	10	10	10	5
79	212555	Kulai R F	559	335	28	56	56	56	56	56	28
80	21254	Dakshin Bilash Chhara	97	58	5	10	10	10	10	10	5
81	212568	Batabari	18	11	1	2	2	2	2	2	1
82	212542	Latiachhara	88	53	4	9	9	9	9	9	4

Total investment requirements for this programme for all the five blocks have been worked out separately in a phased manner. The following assumptions have been taken in these computations

Cookstove cost	Rs 100
Overhead (installation cost, etc.)	Rs 20
Total cost	Rs 120
Total cost escalation rate	10%



MAP SHOWING DISSEMINATION OF IMPROVED COOK STOVES (BLOCKWISE)

Total investment for the improved chulha programme (1994-2001) is presented block-wise below.

Table 6.6. Block Kanchanpur

		Total target							
		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Improved Chulhas (Nos)	7501	625	1250	1250	1250	1250	1250	625
	Total investment (Rs lakh)	7 5	0 62	1 25	1 25	1 25	1 25	1 25	0 62
Medium per capita forest	Total Improved Chulhas (Nos)	3897	325	649	649	649	649	647	325
	Total investment (Rs lakh)	3 90	0 32	0 65	0 65	0 65	0 65	0 65	0 32
High per capita forest	Total Improved Chulhas (Nos)	4077	340	679	679	679	679	679	340
	Total investment (Rs lakh)	4 08	0 34	0 68	0 68	0 68	0 68	0 68	0 34
Total for Kanchanpur	Total Improved Chulhas (Nos)	15475	1290	2578	2578	2578	2578	2578	1290
	Total investment (Rs lakh)	15 47	1 29	2 56	2 56	2 56	2 56	2 56	1 29

Table 6.7 Panisagar Block

		Total target							
		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Improved Chulhas (Nos)	17917	1492	2985	2985	2985	2985	2985	1492
	Total investment (Rs lakh)	17 92	1 49	2 98	2 98	2 98	2 98	2 98	1 49
Medium per capita forest	Total Improved Chulhas (Nos)	601	50	100	100	100	100	100	50
	Total investment (Rs lakh)	0 60	0 05	0 10	0 10	0 10	0 10	0 10	0 05
Total for Panisagar	Total Improved Chulhas (Nos)	18518	1542	3085	3085	3085	3085	3085	1542
	Total investment (Rs lakh)	18 52	1 54	3 08	30 8	3 08	3 08	3 08	1 54

Table 6.8 Block Chhamanu

		Total target							
		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Improved Chulhas (Nos)	5884	490	980	980	980	980	980	490
	Total investment (Rs lakh)	5 88	0 49	0 98	0 98	0 98	0 98	0 98	0 49
Medium per capita forest	Total Improved Chulhas (Nos)	4869	406	811	811	811	811	811	406
	Total investment (Rs lakh)	4 87	0 41	0 81	0 81	0 81	0 81	0 81	0 41
Medium per capita forest	Total Improved Chulhas (Nos)	2092	174	348	348	348	348	348	174
	Total investment (Rs lakh)	2 09	0 17	0 35	0 35	0 35	0 35	0 35	0 17
Total for Chhamanu	Total Improved Chulhas (Nos)	12845	1070	2139	2139	2139	2139	2139	1070
	Total investment (Rs lakh)	12 85	1 07	2 14	2 14	2 14	2 14	2 14	1 07

Table 6.9. Block Kumarghat

		Total target							
		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Improved Chulhas (Nos)	17458	1454	2908	2908	2908	2908	2908	1454
	Total investment (Rs lakh)	17 46	1 45	2 91	2 91	2 91	2 91	2 91	1 45
Medium per capita forest	Total Improved Chulhas (Nos)	1382	115	230	230	230	230	230	115
	Total investment (Rs lakh)	1 38	0 11	0 23	0 23	0 23	0 23	0 23	0 12
High per capita forest	Total Improved Chulhas (Nos)	1307	109	218	218	218	218	218	109
	Total investment (Rs lakh)	1 31	0 11	0 22	0 22	0 22	0 21	0 21	0 11
Total for Kumarghat	Total Improved Chulhas (Nos)	20147	1678	3356	3356	3356	3356	3356	1678
	Total investment (Rs lakh)	20 15	1 68	3 36	3 36	3 36	3 36	3 36	1 68

Table 6.10 Block Salema

		Total target							
		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Improved Chulhas (Nos)	18060	1504	3008	3008	3008	3008	3008	1504
	Total investment (Rs lakh)	18 06	1 50	3 00	3 01	3 01	3 01	3 01	1 50
Medium per capita forest	Total Improved Chulhas (Nos)	3901	325	649	649	649	649	649	325
	Total investment (Rs lakh)	3 90	0 36	0 65	0 65	0 65	0 65	0 65	0 36
High per capita forest	Total Improved Chulhas (Nos)	632	53	105	105	105	105	105	53
	Total investment (Rs lakh)	0 63	0 05	0 10	0 11	0 10	0 10	0 11	0 05
Total for Salema	Total Improved Chulhas (Nos)	22593	1883	3762	3762	3762	3762	3762	1883
	Total investment (Rs lakh)	22 60	1 90	3 76	3 76	3 76	3 76	3 76	1 90

For installing 89578 improved chulhas in the North Tripura District by the end of 2001, the total financial requirement would be to the tune of Rs 89 58 lakhs Year-wise investment for implementing this programme is presented below

Table 6.11. Target and investment for improved cookstoves in North Tripura district

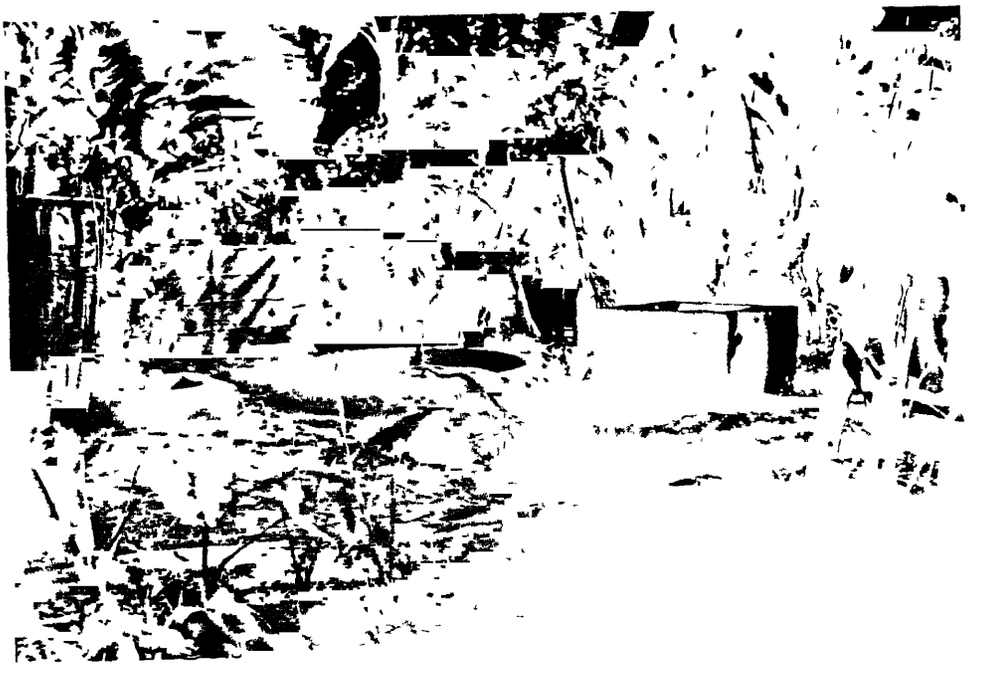
		Total target							
		1994-2001	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Improved Chulhas (Nos)	66820	5565	11138	11138	11138	11138	11138	5565
	Total investment (Rs lakh)	66 82	5 56	11 14	11 14	11 14	11 14	11 14	5 56
Medium per capita forest	Total Improved Chulhas (Nos)	14650	1626	2280	2280	2279	2279	2280	1626
	Total investment (Rs lakh)	14 65	1 63	2 28	2 28	2 28	2 28	2 28	1 62
High per capita forest	Total Improved Chulhas (Nos)	8108	676	1351	1351	1351	1351	1351	676
	Total investment (Rs lakh)	8 11	0 68	1 35	1 35	1 35	1 35	1 35	0 68
Total for district	Total Improved Chulhas (Nos)	89578	7867	14769	14769	14769	14769	14769	7867
	Total investment (Rs lakh)	89 58	7 87	14 77	14 77	14 77	14 77	14 77	7 87

Biogas

There is a vast potential for biogas in the region which if tapped can meet cooking energy demand to a considerable extent Currently, very little animal waste finds use as a source of energy Stallfeeding of animals is rare, consequently very little animal waste is collected As shown in chapter 3, the total dung availability in the district is over 447 tonnes per year At the rate of five cattle required for installing a biogas plant of 2 cu m , the number of potential biogas plants have been worked out village-wise, assuming a 10% penetration level[5] Many villages did not have livestock information, so biogas potential could not be worked out Strategy for identifying villages for biogas is same as it was for estimating energy demand during the primary survey in North Tripura district. Strategy for implementing and phasing biogas programme village-wise is same as in the case of improved chulha programme Block-wise biogas programme is presented below:

[5]The list of villages on which data was collected on livestock, did not match the list available from the census Therefore, forest and phasing of biogas plants has been done separately for those villages not found in the census

Battery charging by wind and solar photovoltaic systems in Jumpai hills



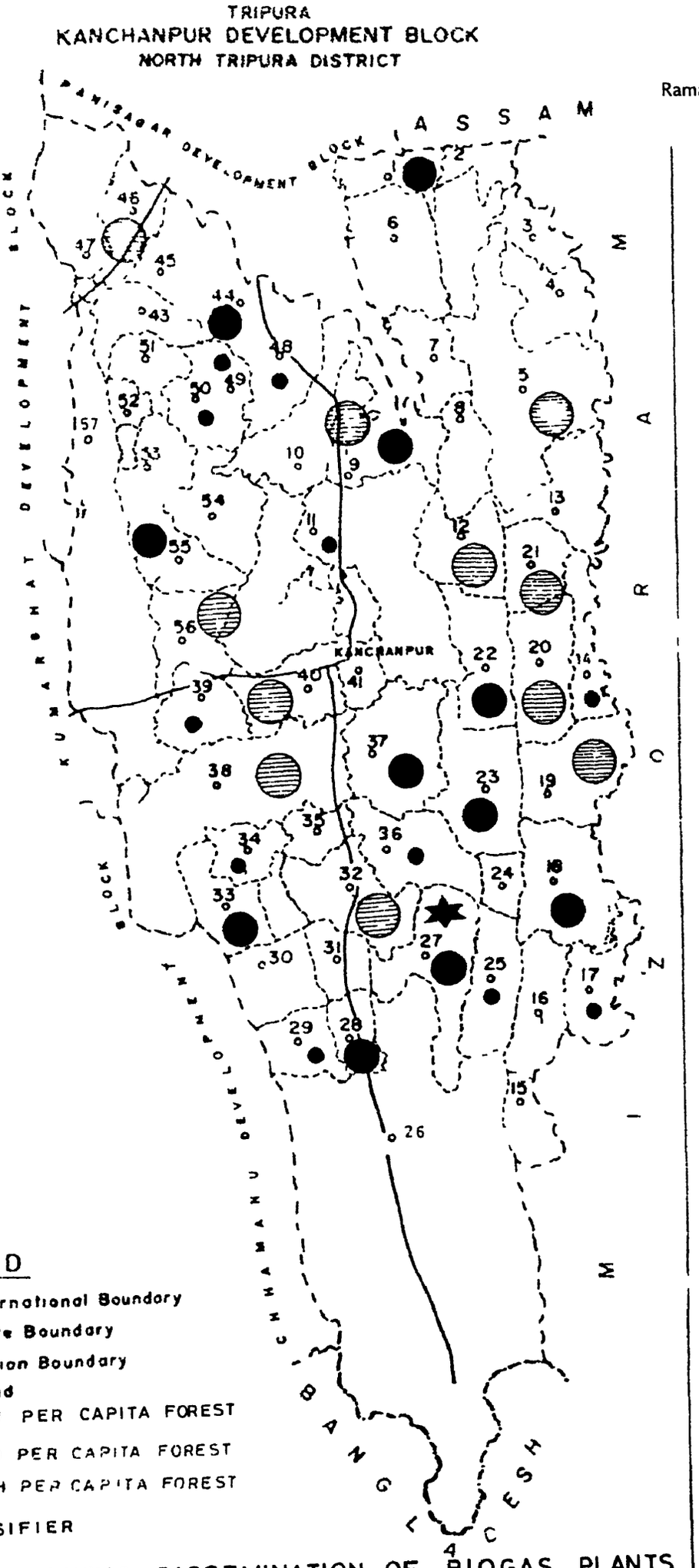
A successful KVIC biogas plant

Table 6.12 Target and phasing of biogas programme in Block Kanchanpur (1994-2001)

Code No	Location	Total cattle pop	Potential Biogas plt	Target							
				10% pene	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
				Villages with low per capita forest land							
212141	Kanchanpur	2168	434	43	4	7	7	7	7	7	4
212110	Laljuri	2002	401	40	4	7	7	7	7	7	4
212152	Dhanichhara	3335	667	67	6	11	11	11	11	11	6
212142	Santipur	987	197	20	2	3	3	3	3	3	2
212148	Pencharthal	1278	256	26	2	4	4	4	4	4	2
212111	Sibnagar	2257	451	45	4	7	7	7	7	7	4
212136	Dasda Laxmipur	2730	546	55	5	9	9	9	9	9	5
212140	Kanchanchhara	895	179	18	2	3	3	3	3	3	2
21212	Damchhara	787	157	16	1	3	3	3	3	3	1
212151	Nalkata	624	125	12	1	2	2	2	2	2	1
212137	Satnala	3102	620	62	6	10	10	10	10	10	6
				Villages with medium per capita forest land							
212155	Dakhin Machmara	4016	803	80	7	13	13	13	13	13	7
212129	Kalapania	77	15	2	0	0	0	0	0	0	0
212144	Nabinchhara	315	63	6	1	1	1	1	1	1	1
212113	Khedachhara	217	43	4	0	1	1	1	1	1	0
21211	Rahum Chhara	201	40	4	0	1	1	1	1	1	0
212127	Gachirampara	200	40	4	0	1	1	1	1	1	0
212150	Baghaichhara	1103	221	22	2	4	4	4	4	4	2
212114	Kalagang	75	15	2	0	0	0	0	0	0	0
212147	Paschim Andharchhara	430	86	9	1	1	1	1	1	1	1
212122	Paschim Manpai	75	15	2	0	0	0	0	0	0	0
				Villages with high per capita forest land							
212139	Chandipur	658	132	13	1	2	2	2	2	2	1
212116	Sabual	16	3	0	0	0	0	0	0	0	0
21214	Kacharichhara	346	69	7	1	1	1	1	1	1	1
21216	Pipla Chhara	274	55	5	1	1	1	1	1	1	1
21219	Ujan Machmara R.F	553	111	11	1	2	2	2	2	2	1
212119	Bhangmun	26	5	1	0	0	0	0	0	0	0
212125	Paschim Tlangsanbari	44	9	1	0	0	0	0	0	0	0
212112	Jamaraipara	159	32	3	0	1	1	1	1	1	0
212138	Manu chailengta R F	507	101	10	1	2	2	2	2	2	1
21215	Damchhara R F	212	42	4	0	1	1	1	1	1	0
21218	Jayantipara	443	89	9	1	1	1	1	1	1	1

Table 6.13. Target and phasing of biogas Programme in villages not in the Census Document (Kanchanpur)

Location	Total cattle pop	Potential Biogas plt	10% pene	Target						
				1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Thumsarai Para	149	30	3	0	0	0	0	0	0	0
Kachchan Para	262	52	5	0	1	1	1	1	1	0
Subhash Nagar	1441	288	29	3	5	5	5	5	5	3
Basemani Para	204	41	4	0	1	1	1	1	1	0
Monacherra	294	59	6	1	1	1	1	1	1	1
Ramguna Para	702	140	14	1	2	2	2	2	2	1
Kangrai Para	0	0	0	0	0	0	0	0	0	0
Bhandarima	367	73	7	1	1	1	1	1	1	1
Ful Dangsai	16	3	0	0	0	0	0	0	0	0
Shakhan Sharmaan	0	0	0	0	0	0	0	0	0	0
Anandasagar Bazar	995	199	20	2	3	3	3	3	3	2
Makumcherra	1028	206	21	2	3	3	3	3	3	2
Chota Dumbur	696	139	14	1	2	2	2	2	2	1
Khalejay Para	338	68	7	1	1	1	1	1	1	1
Tuisama	571	114	11	1	2	2	2	2	2	1
Birmani Para	253	51	5	0	1	1	1	1	1	0
East Bhandarima	381	76	8	1	1	1	1	1	1	1
Langai cherra	92	18	2	0	0	0	0	0	0	0



MAP SHOWING DISSEMINATION OF BIOGAS PLANTS (BLOCKWISE)

TERI REPORT NO 92/RE/62 (1994)

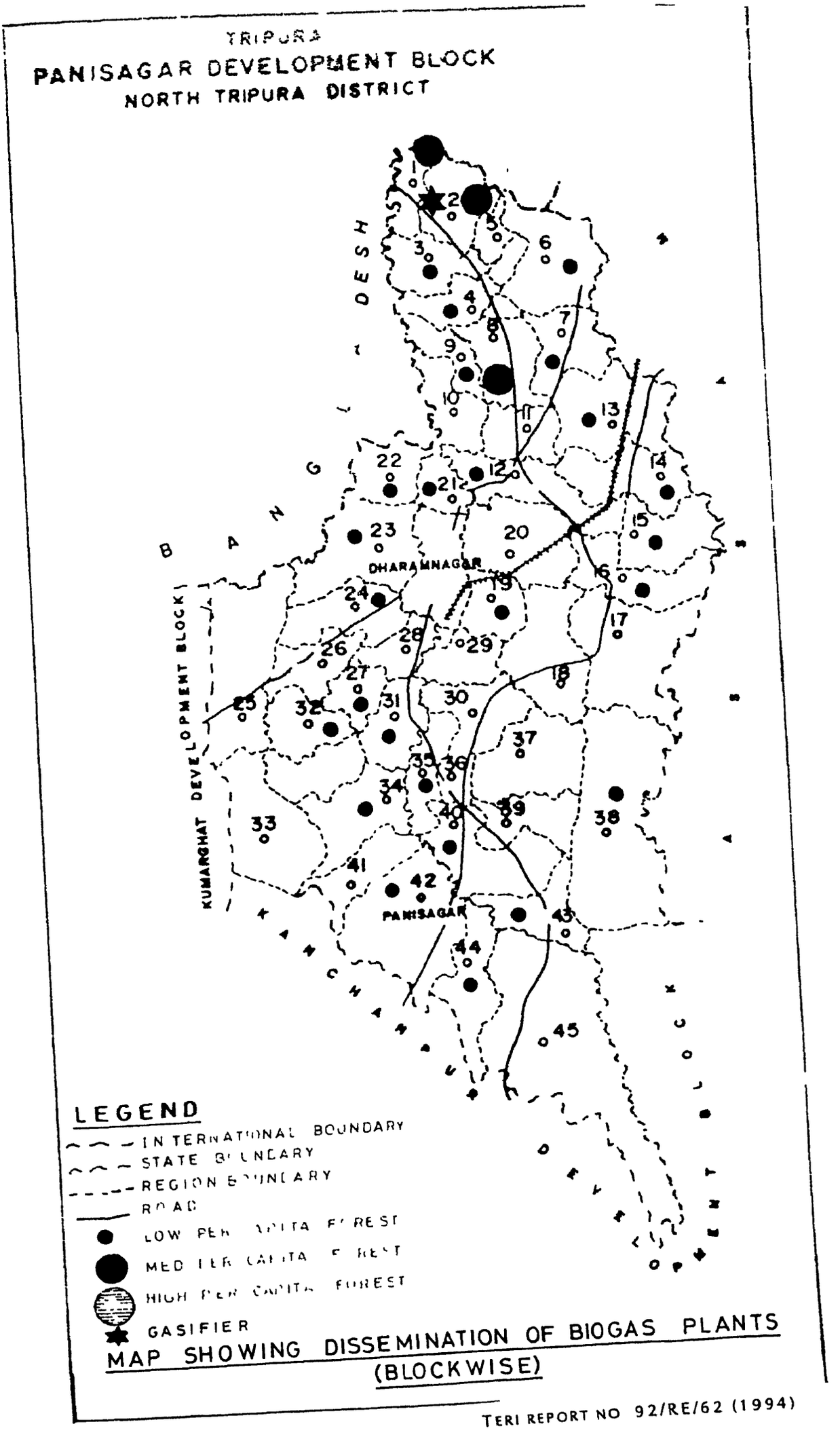
Table 6.14. Target and phasing of biogas programme in Block Panisagar (1994-2001)

Code No	Location	Total cattle	Potential biogas plt	10% pene	Target						
					1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
	Villages with low per capita forest land										
21226	Kurti	1610	322	32	3	5	5	5	5	5	3
212219	Kameswar	248	50	5	0	1	1	1	1	1	0
212211	Ichailalchhara	1044	209	21	2	3	3	3	3	3	2
21227	Kadamtala	2337	467	47	4	8	8	8	8	8	4
21225	Piarachhara										
212222	Ragna	980	196	20	2	3	3	3	3	3	2
212230	Uptakhali	1436	287	29	3	5	5	5	5	5	3
212228	Radhapur	1470	294	29	3	5	5	5	5	5	3
212212	Pratyekrai	759	152	15	1	2	2	2	2	2	1
212227	Purba Halflong	1663	333	33	3	5	5	5	5	5	3
212220	Hurua	4422	884	88	8	14	14	14	14	14	8
212210	Bishnupur	686	137	14	1	2	2	2	2	2	1
212221	Bhagyapur	1002	200	20	2	3	3	3	3	3	2
212223	Baruakandi	1082	216	22	2	4	4	4	4	4	2
212229	Dhupirband	748	150	15	1	2	2	2	2	2	1
212218	Ganganagar	1996	399	40	4	6	6	6	6	6	4
21228	Saraspur	2758	552	55	5	9	9	9	9	9	5
21221	Satsangam	1673	335	33	3	5	5	5	5	5	3
21223	Brajendranagar	1390	278	28	3	5	5	5	5	5	3
212224	Dewanpasa	1203	241	24	2	4	4	4	4	4	2
21222	Ranibari	767	153	15	1	2	2	2	2	2	1
212213	Churaibari	1384	277	28	3	5	5	5	5	5	3
212216	Sanichhara	1034	207	21	2	3	3	3	3	3	2
212231	Jubarajnagar	1342	268	27	2	4	4	4	4	4	2

Code No	Location	Total cattle	Potential biogas plt	10% pene	Target						
					1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
212214	Laxminagar	926	185	19	2	3	3	3	3	3	2
212226	Paschim Halflong	1663	333	33	3	5	5	5	6	6	3
					Villages with low per capita forest land						
212217	Bagbasa	453	91	9	1	1	1	1	1	1	1
212225	Balidhum	353	71	7	1	1	1	1	1	1	1
212215	Chandpur	508	102	10	1	2	2	2	2	2	1

Table 6.15 Target and phasing of biogas programme for villages not in the Census Document (Panisagar)

Location	Total cattle	Potential Biogas plt	10% pene	Target						
				1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Bilthai	1213	243	24	2	4	4	4	4	4	2
Panisagar	3267	653	65	6	11	11	11	11	11	6
Roa	1610	322	32	3	5	5	5	5	5	3
Jalebasa	2093	419	42	4	7	7	7	7	7	4
Indurial	754	151	15	1	2	2	2	2	2	1
Juri R F	212	42	4	0	1	1	1	1	1	0
Pekuchhara	581	116	12	1	2	2	2	2	2	1
Agnipassa	722	144	14	1	2	2	2	2	2	1
Bali Cherra	101	20	2	0	0	0	0	0	0	0
Kalagang Para	1576	315	32	3	5	5	5	5	5	3
Dakhin Choral Bans	1316	263	26	2	4	4	4	4	4	2
Jaithang	192	38	4	0	1	1	1	1	1	0
Tangibari	805	161	16	1	3	3	3	3	3	1
Rajnagar	1793	359	36	3	6	6	6	6	6	3
Uttar Padmabil	2492	498	50	5	8	8	8	8	8	5
Deochhara	1405	281	28	3	5	5	5	5	5	3
Ramnagar	579	116	12	1	2	2	2	2	2	1
Lal Cherra	756	151	15	1	2	2	2	2	2	1
Paschim Tilthai	3498	700	70	7	11	11	11	11	11	7



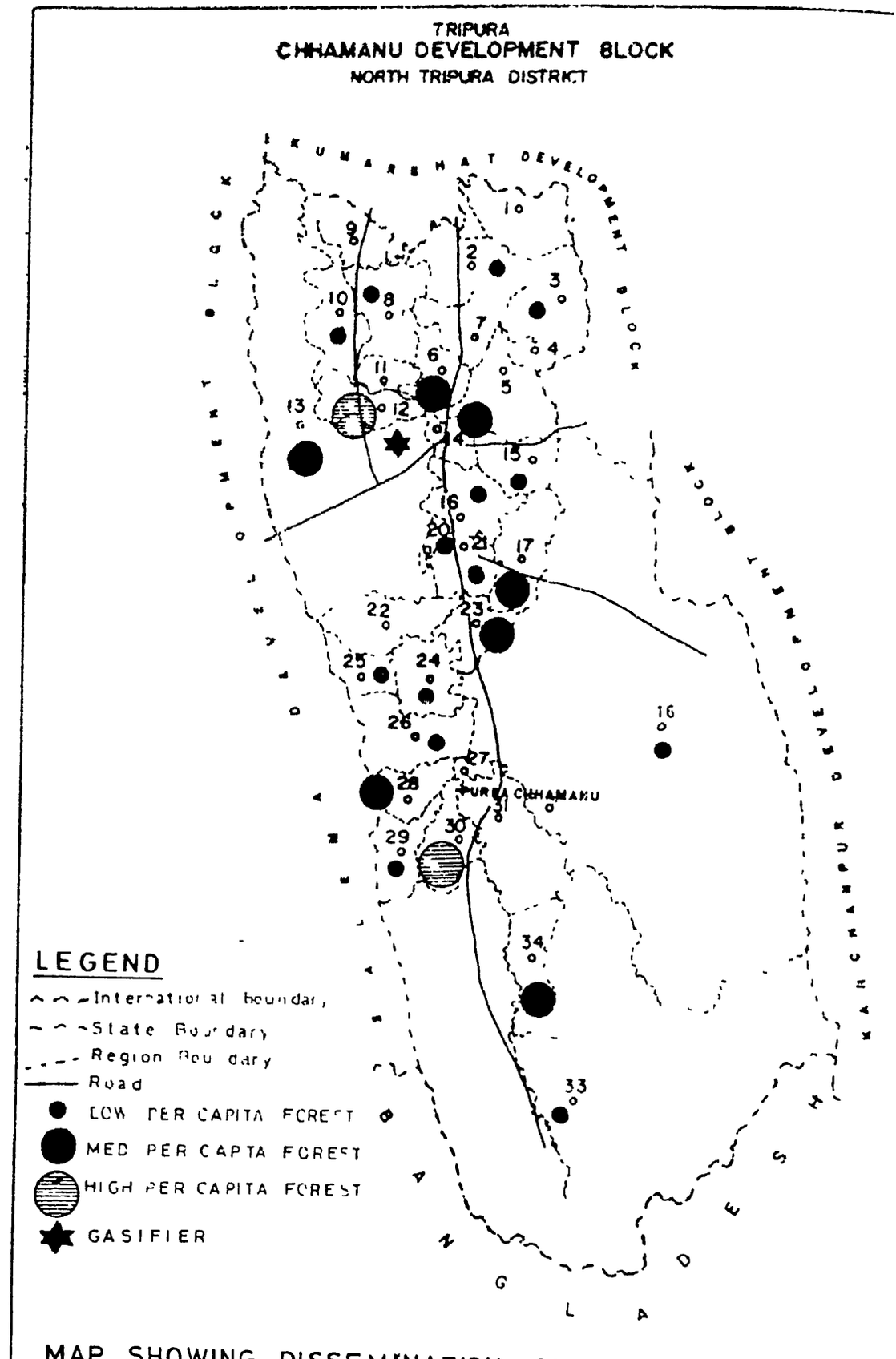
MAP SHOWING DISSEMINATION OF BIOGAS PLANTS (BLOCKWISE)

Table 6.16 Target and phasing for biogas programme in Block Chhamanu (1994-2001)

Location Code No	Name of Village	Total Cattle pop	Potential Biogas plt	10% pene	Target						
					1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
					Villages with low per capita forest land						
212320	Gainarma	178	36	4	0	1	1	1	1	1	0
212321	Chhailengta	1359	272	27	3	4	4	4	4	4	3
212319	Jamirchhara	1106	221	22	2	4	4	4	4	4	2
212318	Mainama	1397	279	28	3	5	5	5	5	5	3
21235	Purba Masli	1109	222	22	2	4	4	4	4	4	2
212332	Manikpur	203	41	4	0	1	1	1	1	1	0
21237	Paschim Karamchhara	794	159	16	1	3	3	3	3	3	1
212314	Manu	1347	269	27	3	4	4	4	4	4	3
212311	Uttar Dhumachhara	750	150	15	1	2	2	2	2	2	1
212317	Lalchhara	362	72	7	1	1	1	1	1	1	1
212312	Dakshin Dhumachhara	913	183	18	2	3	3	3	3	3	2
212330	Paschim Chhamanu	781	156	16	1	3	3	3	3	3	1
21236	Paschim Masli	509	102	10	1	2	2	2	2	2	1
21239	Kathalchhara	917	183	18	2	3	3	3	3	3	2
					Villages with medium per capita forest land						
21234	Purba Karamchhara	1024	205	20	2	3	3	3	3	3	2
212323	Durgachhara	841	168	17	2	3	3	3	3	3	2
21238	Karatichhara	520	104	10	1	2	2	2	2	2	1
212310	Demchhara	280	56	6	1	1	1	1	1	1	1
212328	Uttar Longtarai	248	50	5	0	1	1	1	1	1	0
21231	Kanchanchhara	794	159	16	1	3	3	3	3	3	1
21232	Nalkata	808	162	16	2	3	3	3	3	3	2
					Villages with high per capita forest land						
212326	Sadhujanpur	1158	232	23	2	4	4	4	4	4	2
212325	Joy Chandra Para	798	160	16	1	3	3	3	3	3	1

Table 6.17 Target and phasing for biogas programme in the villages not in the Census document (Chhamanu)

Name of the village	Total Cattle pop	Potential Biogas plt	10% pene	Target						
				1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Baltalia										
Chichingcherra	397	79	8	1	1	1	1	1	1	1
Dee R F										
Delu-cherra	531	106	11	1	2	2	2	2	2	1
Purba Gobindabair	258	52	5	0	1	1	1	1	1	0
Laben-cherra	724	145	14	1	2	2	2	2	2	1
Malidhar (East)										
Malidhar (West)	561	112	11	1	2	2	2	2	2	1
Paschim Gobindabari	186	37	4	0	1	1	1	1	1	0



MAP SHOWING DISSEMINATION OF BIOGAS PLANTS (BLOCKWISE)

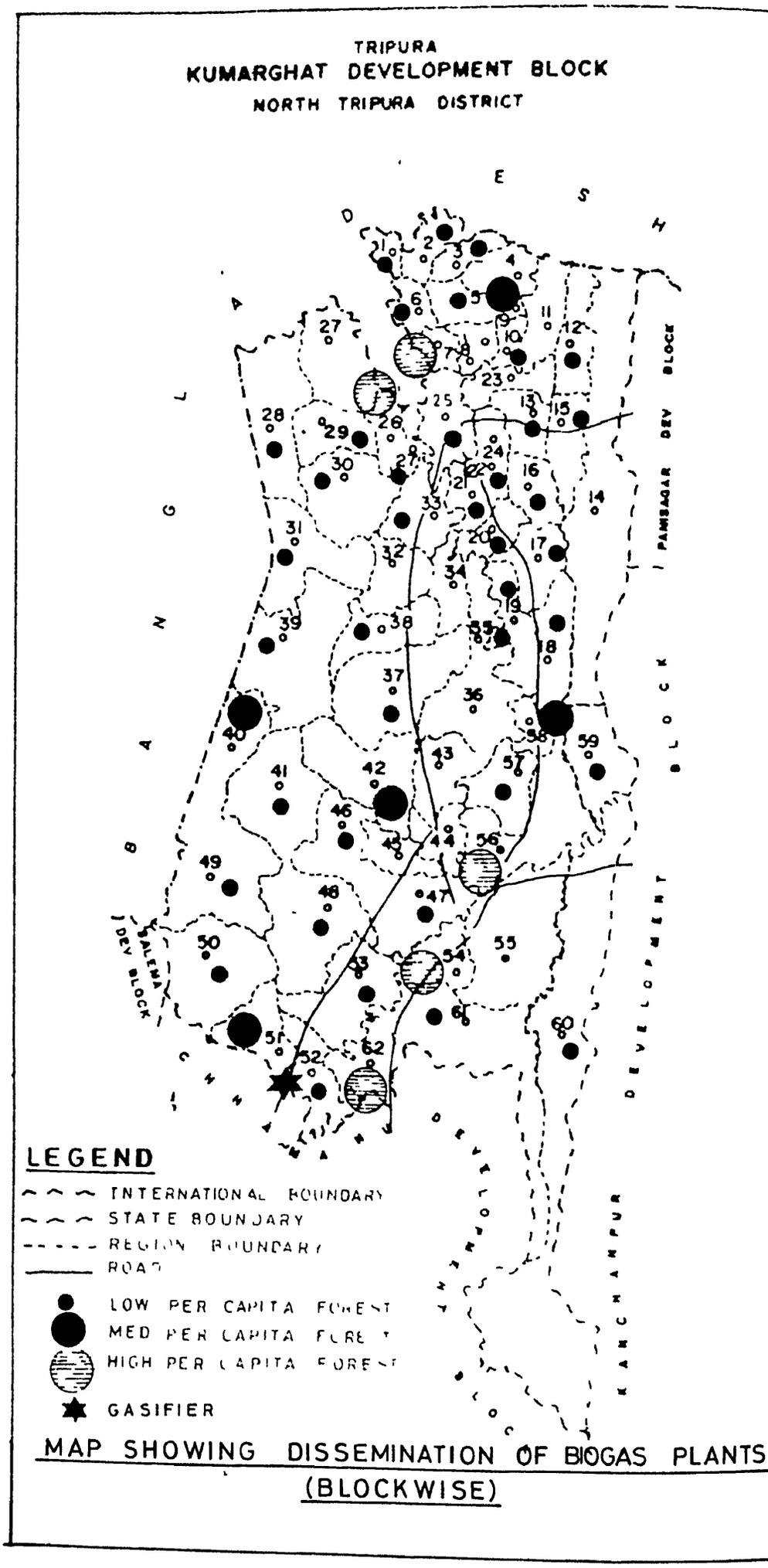
Table 6.18. Target and phasing of biogas programme in Block Kumarghat (1994-2001)

Location Code No	Name of Village	Total Cattle pop	Potential Biogas plt	10% pene	Target						
					1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
	Villages with low per capita forest land										
212423	Jubarajnagar	250	50	5	0	1	1	1	1	1	0
21248	Ichabpur	616	123	12	1	2	2	2	2	2	1
21246	Kamrangaban	601	120	12	1	2	2	2	2	2	1
212412	Gakulnagar	1156	231	23	2	4	4	4	4	4	2
212413	Fultali	724	145	14	1	2	2	2	2	2	1
21245	Guldharpur	637	127	13	1	2	2	2	2	2	1
21247	Gournagar	336	67	7	1	1	1	1	1	1	1
212425	Rangauti	834	167	17	2	3	3	3	3	3	2
212421	Laxmipur	688	138	14	1	2	2	2	2	2	1
212422	Tilagaon	469	94	9	1	2	2	2	2	2	1
21241	Srirampur	461	92	9	1	2	2	2	2	2	1
212420	Kaulikura	1057	211	21	2	3	3	3	3	3	2
212426	Latiapur	348	70	7	1	1	1	1	1	1	1
21249	Krishnanagar	787	157	16	1	3	3	3	3	3	1
212419	Dhanbilash	1397	279	28	3	5	5	5	5	5	3
21242	Chandipur	702	140	14	1	2	2	2	2	2	1
21243	Chantail	1270	254	25	2	4	4	4	4	4	2
212427	Dhaliarkandi	312	62	6	1	1	1	1	1	1	1
212410	Fatikroy	580	116	12	1	2	2	2	2	2	1
212416	Bilashpur	868	174	17	2	3	3	3	3	3	2
212431	Srinathpur	1136	227	23	2	4	4	4	4	4	2
212433	Masauli	1305	261	26	2	4	4	4	4	4	2
212434	Paschim Kanchanbari	1066	213	21	2	3	3	3	3	3	2
212437	Purba Ratachhara	1040	208	21	2	3	3	3	3	3	2
212438	Sonaimuri	548	110	11	1	2	2	2	2	2	1
212439	Dudhpur	2188	438	44	4	7	7	7	7	7	4
212443	Jalai	726	145	15	1	2	2	2	2	2	1
212444	Jarultali	586	117	12	1	2	2	2	2	2	1
212445	Rangrung	614	123	12	1	2	2	2	2	2	1
212446	Jagannathpur	688	138	14	1	2	2	2	2	2	1
212447	Paschim Ratachhara	2086	417	42	4	7	7	7	7	7	4
212448	Purba Kanchanbari	430	86	9	1	1	1	1	1	1	1
212451	Radhanagar	531	106	11	1	2	2	2	2	2	1
212453	Golakpur	518	104	10	1	2	2	2	2	2	1
212454	Bhagabannagar	631	126	13	1	2	2	2	2	2	1
212455	Laljuri	833	167	17	2	3	3	3	3	3	2

Location Code No	Name of Village	Total Cattle pop	Potential Biogas plt	10% pene	Target						
					1994,95	1995,96	1996/97	1997/98	1998/99	1999/2000	2000/2001
212456	Deorachhara	318	64	6	1	1	1	1	1	1	1
212461	Betchhara	1076	215	22	2	4	4	4	4	4	2
212462	Ganganagar	1708	342	34	3	6	6	6	6	6	3
	Villages with medium per capita forest land										
212411	Manu Valley	742	148	15	1	2	2	2	2	2	1
212418	Sonamukhi	1270	254	25	2	4	4	4	4	4	2
212428	Rajkandi	506	101	10	1	2	2	2	2	2	1
212429	Murtichhara	938	188	19	2	3	3	3	3	3	2
212441	Dengdung	1025	205	21	2	3	3	3	3	3	2
	Villages with high per capita forest land										
21244	Saydachhara	995	199	20	2	3	3	3	3	3	2
212440	Irani	3587	717	72	7	12	12	12	12	12	7
212449	Dakshin Unakuti RF	260	52	5	0	1	1	1	1	1	0
212459	Uttar Unakuti RF	144	29	3	0	0	0	0	0	0	0
212460	Samruhala RF	832	166	17	2	3	3	3	3	3	2

Table 6.19. Target and phasing of biogas programme in the villages not in the census Document

Name of the village	Total Cattle pop	Potential Biogas plt	10% pene	Target						
				1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Darchai	123	25	2	0	0	0	0	0	0	0
Deevelley	284	57	6	1	1	1	1	1	1	1
Durgapur	1616	323	32	3	5	5	5	5	5	3
Fatikchaerra	271	54	5	1	1	1	1	1	1	1
Fulbarikandhi	325	65	7	1	1	1	1	1	1	1
Jmtailbari	515	103	10	1	2	2	2	2	2	1
Kailasahar NAA	2192	438	44	4	7	7	7	7	7	4
Kanchanbari	932	186	19	2	3	3	3	3	3	2
Kumarghat NAA	3107	621	62	6	10	10	10	10	10	6
Madhya Kanchanbari	692	138	14	1	2	2	2	2	2	1
Neerpur	83	17	2	0	0	0	0	0	0	0
Niracherra	130	26	3	0	0	0	0	0	0	0
Sarejini	407	81	8	1	1	1	1	1	1	1
Singibil	137	27	3	0	0	0	0	0	0	0
Tyaghari	267	53	5	0	1	1	1	1	1	0
Yejakhayar	1748	350	35	3	6	6	6	6	6	3
Rajnagar	811	162	16	2	3	3	3	3	3	2
Samrurmukh	88	18	2	0	0	0	0	0	0	0

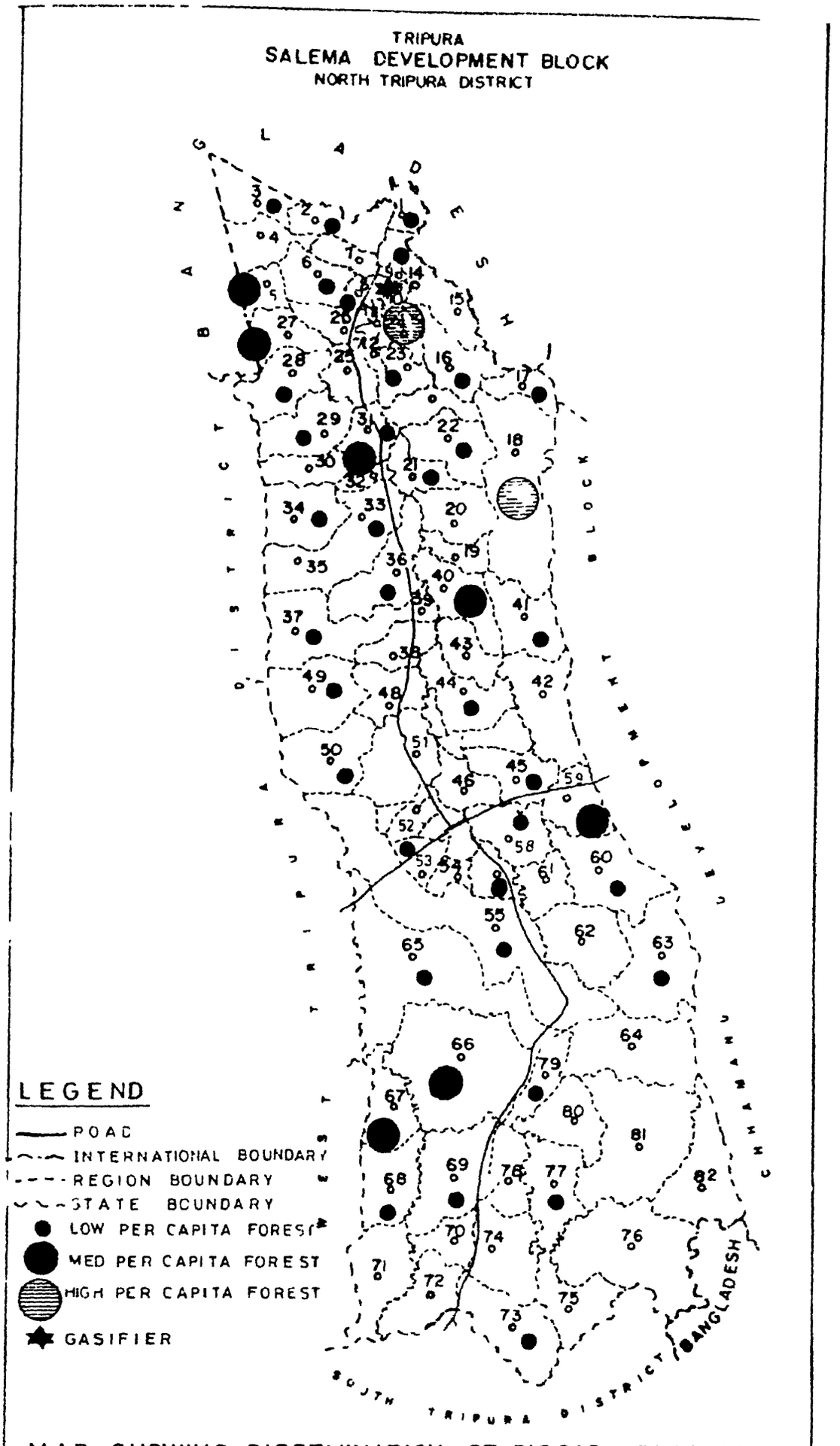


MAP SHOWING DISSEMINATION OF BIOGAS PLANTS (BLOCKWISE)

Table 6.20 Target and Phasing of Biogas Programme in Block Salema (1994-2001)

Location Code No	Name of Village	Total cattle pop	Potential Biogas plt	10% pene	Target						
					1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
	Villages with low per capita forest land										
212525	Manikbhander	2911	582	58	5	9	9	9	9	9	5
212521	Debichhara	3479	696	70	6	11	11	11	11	11	6
212529	Duraichhara	3908	782	78	7	13	13	13	13	13	7
212516	Chotasurma	3960	792	79	7	13	13	13	13	13	7
212524	Chulubari	2313	463	46	4	8	8	8	8	8	4
212513	Kuchainala	2549	510	51	5	8	8	8	8	8	5
212519	Jamthumbari	2729	546	55	5	9	9	9	9	9	5
212526	Kalachhari	1542	308	31	3	5	5	5	5	5	3
21259	Halhali	982	196	20	2	3	3	3	3	3	2
212522	Mahabir	2269	454	45	4	7	7	7	7	7	4
212527	Lembuchhara	2662	532	53	5	9	9	9	9	9	5
212510	Panchasi	2494	499	50	5	8	8	8	8	8	5
212523	Bamanchhara	1462	292	29	3	5	5	5	5	5	3
212533	Baraluthma	1812	362	36	3	6	6	6	6	6	3
212528	Srirampur	2402	480	48	4	8	8	8	8	8	4
212551	Purba Nalichhara	1542	308	31	3	5	5	5	5	5	3
212548	Purba Daluchhara	3150	630	63	6	10	10	10	10	10	6
212531	Halhali	1542	308	31	3	5	5	5	5	5	3
21257	Noagaon	1961	392	39	4	6	6	6	6	6	4
212558	Ambasa	1944	389	39	4	6	6	6	6	6	4
212515	Marachhara	2491	498	50	5	8	8	8	8	8	5
212560	Sikaribari	1180	236	24	2	4	4	4	4	4	2
212557	Kanchanpur	2204	441	44	4	7	7	7	7	7	4
212538	Salema	1833	367	37	3	6	6	6	6	6	3
212544	Kachuchara	5062	1012	101	9	16	16	16	16	16	9
212559	Kathalbari	815	163	16	2	3	3	3	3	3	2
212552	Kulai	1206	241	24	2	4	4	4	4	4	2
212543	Debbari	1146	229	23	2	4	4	4	4	4	2
212562	Harimangalpara	666	133	13	1	2	2	2	2	2	1
21256	Mayachhari	2332	466	47	4	8	8	8	8	8	4
212553	Kamalachhara	2755	551	55	5	9	9	9	9	9	5
212546	Lalchhari	2464	493	49	5	8	8	8	8	8	5
212536	Abhanga	2694	539	54	5	9	9	9	9	9	5
212540	Michhuria	1664	333	33	3	5	5	5	5	5	3
212547	Balaram	1077	215	22	2	4	4	4	4	4	2
212539	Maharani	1321	264	26	2	4	4	4	4	4	2
212530	Apareshkar	994	199	20	2	3	3	3	3	3	2

Location Code No	Name of Village	Total cattle pop	Potential Biogas plt.	10% pene	Target						
					1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
	Villages with medium per capita forest land										
212545	Bagmara	348	70	7	1	1	1	1	1	1	1
212537	Mendi	458	92	9	1	1	1	1	1	1	1
212550	Paschim Nalichhara	540	108	11	1	2	2	2	2	2	1
212549	Paschim Daluchhara	785	157	16	1	3	3	3	3	3	1
212563	Gurudhan Para	1238	248	25	2	4	4	4	4	4	2
21254	Dakshin Bilash Chhara	1616	323	32	3	5	5	5	5	5	3
212568	Batabari*	2772	554	55	5	9	9	9	9	9	5



MAP SHOWING DISSEMINATION OF BIOGAS PLANTS (BLOCK WISE) TERI REPORT NO 92/RE/62 (1994)

Table 6.21. Target and Phasing of Biogas Programme in the villages which are not in the Census Document (Salema)

Name of village	Total cattle pop	Potential Biogas plt.	10% pene	Target						
				1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Gantacherra	1051	210	21	2	3	3	3	3	3	2
Geelcherra	1238	248	25	2	4	4	4	4	4	2
Kamalpur Notified Area	1337	267	27	2	4	4	4	4	4	2
Krishnanagar	1093	219	22	2	4	4	4	4	4	2
Narekhala	1424	285	28	3	5	5	5	5	5	3
Setrai	360	72	7	1	1	1	1	1	1	1

Total investment in the Biogas Programme till the end of year 2001 would be Rs. Rs. 385.77 lakhs for 5511 biogas plants. The total investment for the biogas programme is further divided year-wise with the number of biogas plants to be disseminated. There are villages in each block which do not correspond with the villages in the census document. Livestock census block-wise village list is not same as of census Therefore, target and phasing of biogas plants have been done separately for these villages. Implementation of biogas programme can be done for these villages simultaneously with the villages in the category of low per capita forest land and the villages in the medium per capita forest land Total investment which will be incurred in the biogas programme year-wise have been worked out for the five blocks Assumptions made for the cost the biogas plant are as follows

Biogas cost (w/o labour, and charging cost for a 2m3 plant)	Rs. 7200
Overhead	Rs. 720
Total	Rs. 7920
Annual rate of cost escalation	10%

Table 6.22 North Tripura district

			Investment (1994-2001) for the biogas programme (Rs Lakhs)						
			1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest land	Total Biogas plants (Nos)	3582	333	584	584	584	584	584	333
	Total investment (Rs lakhs)	250 74	23 31	40 88	40 88	40 88	40 88	40 88	23 31
Medium per capita forest land	Total Biogas plants (Nos)	493	45	81	81	81	81	81	45
	Total investment (Rs lakhs)	34 51	3 15	5 67	5 67	5 67	5 67	5 67	3 15
High per capita forest land	Total Biogas plants (Nos)	308	31	50	50	50	50	50	31
	Total investment (Rs lakhs)	21 56	2 17	3 50	3 50	3 50	3 50	3 50	2 17
Villages not in census	Total Biogas plants (Nos)	1128	105	184	184	184	184	184	105
	Total investment (Rs lakhs)	78 96	7 35	12 88	12 88	12 88	12 88	12 88	7 35
	Total Biogas plants (Nos)	5511	512	899	899	899	899	899	512
	Total investment (Rs lakhs)	385 77	35 84	62 93	62 93	62 93	62 93	62 93	35 84

Table 6.23. Block Kanchanpur

			Investment (1994-2001) for the biogas programme (Rs Lakhs)						
			1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Biogas plants (Nos)	403	37	66	66	66	66	66	37
	Total investment (Rs lakhs)	28.23	2 62	4 60	4 60	4 60	4 60	4 60	2 62
Medium per capita forest	Total Biogas plants (Nos)	148	14	24	24	24	24	24	14
	Total investment (Rs lakhs)	10 39	0 97	1 69	1 69	1 69	1 69	1 69	0 97
High per capita forest	Total Biogas plants (Nos)	65	6	11	11	11	11	11	6
	Total investment (Rs lakhs)	4 53	0 42	0 74	0 74	0 74	0 74	0 74	0 42
Villages not in census	Total Biogas plants (Nos)	156	14	25	25	25	25	25	14
	Total investment (Rs lakhs)	10 91	1 01	1 78	1 78	1 78	1 78	1 78	1 01
	Total Biogas plants (Nos)	772	71	126	126	126	126	126	71
	Total investment (Rs lakhs)	54 06	5 02	8 81	8 81	8 81	8 81	8 81	5 02

Table 6.24. Block Panisagar

			Investment (1994-2001) for the biogas programme (Rs lakhs)						
			1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Biogas plants (Nos)	712	66	116	116	116	117	117	66
	Total investment (In lakhs)	49 85	4 63	8 09	8 09	8 09	8 16	8 16	4 63
Medium per capita forest	Total Biogas plants (Nos)	26	2	4	4	4	4	4	2
	Total investment (In lakhs)	1 84	0 17	0 30	0 30	0 30	0 30	0 30	0 17
Villages not in census	Total Biogas plants (Nos)	514	48	84	84	84	84	84	48
	Total investment (In lakhs)	35 99	3 35	5 86	5 86	5 86	5 86	5 86	3 35
	Total Biogas plants (Nos)	1252	116	204	204	204	204	204	116
	Total investment (In lakhs)	87 68	8 15	14 25	14 25	14 25	14 25	14 25	8 15

Table 6.25 Block Chhamanu

			Investment (1994-2001) for the biogas programme (Rs lakhs)						
			1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total Biogas plants (Nos)	235	22	38	38	38	38	38	22
	Total investment (In lakh)	16 42	1 53	2 67	2 67	2 67	2 67	2 67	1 53
Medium per capita forest	Total Biogas plants (Nos)	90	8	15	15	15	15	15	8
	Total investment (In lakh)	6 32	0 59	1 03	1 03	1 03	1 03	1 03	0 59
High per capita forest	Total Biogas plants (Nos)	39	4	6	6	6	6	6	4
	Total investment (In lakh)	2 74	0 25	0 45	0 45	0 45	0 45	0 45	0.25
Villages not in census	Total Biogas plants (Nos)	53	5	9	9	9	9	9	5
	Total investment (In lakh)	3 72	0 35	0 61	0 61	0 61	0 61	0 61	0 35
	Total Biogas plants (Nos)	417	39	68	68	68	68	68	39
	Total investment (In lakh)	29 2	2 72	4 76	4 76	4 76	4 76	4 76	2 72

Table 6.26. Block Kumarghat

			Investment (1994-2001) for the biogas programme						
			1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest	Total biogas plants (Nos)	642	60	105	105	105	105	105	60
	Total investment (Rs lakhs)	44 97	4 18	7 32	7 32	7 32	7 32	7 32	4 18
Medium per capita forest	Total biogas plants (Nos)	90	8	15	15	15	15	15	8
	Total investment (Rs lakhs)	6 27	0 58	1 02	1 02	1 02	1 02	1 02	0 58
High per capita forest	Total biogas plants (Nos)	116	11	19	19	19	19	19	11
	Total investment (Rs lakhs)	8 15	0 76	1 33	1 33	1 33	1 33	1 33	0 76
Villages not in census	Total biogas plants (Nos)	275	26	45	45	45	45	45	26
	Total investment (Rs lakhs)	19 22	1 79	3 13	3 13	3 13	3 13	3 13	1 79
	Total biogas plants (Nos)	1123	105	184	184	184	184	184	105
	Total investment (Rs lakhs)	78 61	7 31	12 8	12 8	12 8	12 8	12 8	7 31

Table 6.27. Block Salema

			1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/2001
Low per capita forest land	Total Biogas plants (Nos)	1590	148	259	259	259	259	259	148
	Total investment (Rs lakhs)	111 32	10 35	18 12	18 12	18 12	18 12	18 12	10 35
Medium per capita forest land	Total Biogas plants (Nos)	139	13	23	23	23	23	23	13
	Total investment (Rs lakhs)	9 75	0 91	1 59	1 59	1 59	1 59	1 59	0 91
High per capita forest land	Total Biogas plants (Nos)	88	8	14	14	14	14	14	8
	Total investment (Rs lakhs)	6 14	0 57	1 00	1 00	1 00	1 00	1 00	0 57
Villages not in census	Total Biogas plants (Nos)	130	12	21	21	21	21	21	12
	Total investment (Rs lakhs)	9 10	0 85	1 48	1 48	1 48	1 48	1 48	0 85
	Total Biogas plants (Nos)	1947	181	317	317	317	317	317	181
	Total investment (Rs lakhs)	136 31	12 68	22 19	22 19	22 19	22 19	22 19	12 68

A consolidated statement of the technology targets and their investment requirements have been presented in table 6.28 This includes gasifier as well as microhydel technologies

Table 6.28 Proposed Renewable Devices for North Tripura district

Block/Devices	Biogas	Improved Chulha	Biomass Gasifier	Mini/Micro Hydel
Kanchanpur	772	15475	1	2
Chhamanu	417	12845	1	1
Panisagar	1252	18518	1	1
Kumarghat	1123	20147	1	11
Salema	1947	22593	1	5
Total No. of Devices	5511	89578	5	20
Total Investment (Lakhs)	385.77	89.58	3.85	4000

Demonstrative technologies

Biomass gasifiers and briquetting

Biomass gasification technology offers scope for a higher efficiency of use of biomass, and replacement of petroleum fuels such as diesel. The major thrust of application in India has been on small (5 HP) irrigation pumpsets The gasifiers are designed to use firewood chips of average size of 1"-2" Biomass gasifiers can use agricultural residue also in the form of briquettes. The briquettes can replace fuelwood in the cookstoves in domestic sector, restaurants and industries.

There are a number of options for power generation like biomass gasification, biogas, wind energy and solar photovoltaics Among these, the biomass gasification based power generation system is feasible to most locations in India. Wind energy systems require expensive storage facilities. Not all the locations are suitable for harnessing wind energy because of low and varying wind velocities. Solar photovoltaics are highly expensive per kW (about Rs. 3 lacs per kW of installed capacity as compared to about Rs 0.15 lacs for a gasifier based system) of installed capacities The biomass gasification using agricultural waste seems to be an ideal option for most locations in India. The gasifier designs have been indigenously developed and are commercially available for various capacities like, 3.7 kW, 20 kW, 40 kW and 100 kW. These gasifiers were mainly designed to utilise wood as biomass Tata Energy Research Institute has developed a multifuel, multipurpose biomass gasifiers of capacities of 16 kW and 40 kW.

Principle of a gasifier system

A gasifier is a unit that generates producer gas (a mixture of CO, H_2, and a small fraction of CH_4) by burning biomass fuels. The producer gas is cooled and cleaned before letting it into the diesel engine It replaces diesel in the diesel engine (an average of 70% has been achieved in the field runs) The engine is connected to an alternator to produce electricity. The engine can also be connected to a pulverizer and a briquetting machine when required

Description of the system adopted by TERI

The system consists broadly of (i) the main gasifier unit with associated cooling-cleaning train, (ii) the prime mover with associated torque-transmitting system, and (iii) various accessories/end-use devices driven by the prime mover These devices are (a) chopper, (b) pulverizer, (c) briquetting machine, and (d) 7 5 kVA alternator, and are coupled to a common shaft through belt drives. Flat belts are used for easy removal and

coupling. An electrically operated circular saw was also used for cutting mustard stalks, but has been replaced by the chopper as the output of the saw was very low. In regular operation, the gasifier is loaded with briquettes, the diesel engine and blower started, and the bed is then ignited by a flaming torch. A few minutes after, burning gas is obtained, the gas is diverted to the diesel engine and the blower switched off, depending on the requirement at hand one of the various devices driven from the main shaft is operated

Briquettes

Two methods of briquetting are in vogue at present. One consists of subjecting the biomass to a very high pressure (1200 kg/cm^2), and is known as binderless briquetting. The density of briquettes obtained is fairly high, and the machines are commercially available The second method consists of adding a binder, such as molasses, to the loose fuel particles and extruding the mixture at low pressures (200 kg/cm^2). The resulting briquettes have a lower bulk density This process however, has so far been applied to char or coal dust, using molasses, clay, etc as binding agents In TERI design, the method has been successfully adopted for pulverised biomass, using biogas plant effluent slurry as binder

Biomass requirement and availability

There are two major options of biomass for gasification One is wood and the other is biomass wastes like agricultural waste, coconut waste, waste from saw mills (saw dust and waste wood pieces) and sugarcane leaves The third option though minor at present but significant in some of the areas in the country is weeds like *Lantana Camera*

The use of crop residues seems to be most feasible for systems installed within the villages for power and thermal requirements For each unit of electricity generated, the consumption of briquettes would be about 1 2 kg and the specific diesel consumption in dual-fuel mode 0 15 lit/kWh. There is a further 'self-consumption' of briquettes and diesel to produce briquettes Hence the total amount of biomass needed, would be 1 38 kg/kWh and diesel required is 0.16 lit/kWh (net)

The experiments done on using briquettes made out of rice husk, saw dust, coir pith, mustard stalk, bajra stalk and groundnut shells have showed reasonably good performance (combustible gases were available within 5 to 10 minutes when used in the gasifier).

Applications and benefits of the option

Self Reliance. Power generation at individual or a cluster of villages level would lead to self reliance of village communities in power requirement

Reliability and stabilized power. The power from centralised supply for rural areas ends up with low and fluctuating voltages and untimely supply of electricity which

* drastically affects the agriculture yield (many of the agriculture pumpsets were burnt because of low voltage)
* the rural people hesitate to take initiative in venturing into small industries
* Children in the village are unable to read even in the electrified households because of the low voltage

This situation could be changed through decentralised power generating units

Sustainability of resources. Since it utilises the agricultural wastes which are locally available, the system would be sustainable.

Industrial applications Residues such as saw-dust, groundnut shell, bamboo dust (from paper mills), etc can be briquetted and gasified *in-situ*, and the gas can be used either in oil fired boilers or in diesel gensets, saving fuel-oil or diesel, respectively.

Cost of the gasifier systems

The major costs include investment on the gasifier system and the operation and maintenance of the system. The cost of investment of a 6 kWe gasifier system based on agro-residue are given in appendix table 6 29.

The investment cost involves, the cost of engine, alternator, building to house the system, and the accessaries The total cost of a biomass gasifier unit would be approximately Rs. 12,000 per kilowatt of installed capacity

Operation and Maintenance cost The cost of operation and maintenance per kWh is about Rs.1.91 The cost of operating includes, the cost of diesel Rs. 0 99 per kWh (@ Rs 6 80/litre), biomass and its processing Rs 0.49/kWh (Rs 300 per tonne for crop residue, Rs.0 05 for processing crop residue into briquettes) and other costs like lubrication oil, filtering system, diesel transportation, maintenance and labour on operation of the system Rs.0 43/kWh However, these costs are likely to vary considerably with region to region based on the local characteristics

Table 6.29. Cost details of the present system (6 kWe) installed by TERI at village Dhanawas (Haryana State)

Compounds	Amount (Rs)
Trolly for assembling	14,000
Gasifier	10,000
Cyclone cooler	500
Gas cooler	3,000
Dust filter	500
Grate shaking unit	2,000
Gas distribution line (Pipes, fitting, valves etc)	2,000
Blower for ignition	1,000
Common shaft, pulleys bearing etc	4,000
Alternator (7KVA)	6,000
Diesel engine (10 H.P.)	6,000
Pulveriser	5,000
Briquetting machine	5,000
Chopper	2 000
Assembling charges	3,000
	64,000
Miscellaneous	6,000
Total	70,000

Cost of briquetting

Data from various types of briquetting plants indicate a specific electricity consumption of about 0 1 kWh/kg for power briquetting As the specific electricity generation from gasifier based systems is known to be about 1 kWh/kg, it can be observed that only about 10% of electricity generated is consumed for briquetting In the present system, the total diesel consumption for briquetting in the diesel mode is about 0.025 litre/kg At the rate of Rs 6 80/litre, the fuel cost of conversion of stalks into briquettes works out to 17 paise/kg. In the dual mode, the diesel consumption is about 0 007 litre/kg and the cost of conversion works out to about 5 paise/kg of briquettes Briquettes, thus produced, can be primarily used as feed material for power generation.

Potential of crop residue in North Tripura

The total agricultural waste available from all the crops is about 62693 metric tonnes. Only about 40% of the total agricultural waste produced has been considered to be available for briquetting. An equal quantity of agricultural residue is used as fodder in the villages and it is assumed that about 20% goes either left out in the fields or lost during the whole process of transporting and storage There is negligible loss in the process of converting the agricultural residue into briquettes and thus the total amount of electricity that could be produced through gasification of briquettes is about 44,780,714 kWh. The specific fuel consumption is about 1 4 kg/kWh There is potential to install 123 MW through gasification

Table 6.30 Potential availability of crop residue in North Tripura in the year 1988-89 [Area and production of major crops (North Tripura)]

Crops	Area in Hectares	Production in MT	Grain-residue ratio (by weight)	Annual residue production (MT)	Residue available for briquetting (MT)
Rice	76600	118600	1 25	148250	59300
Maize	300	200	1 56	312	124.8
Wheat	1200	2100	1 33	2793	1117.2
Gram	200	100	1	100	40
Total pulses	3200	1800	1 03	1854	741 6
Groundnut	600	560	2 05	1148	459.2
Rapeseed musturd	1670	1230	1 85	2275 5	910 2
Total	83770	124590		156732 5	62693

Table 6.31 Sites selected for installing gasifier, capacity and usage

S No	Variables	Units					
1	Village		J C Para	Korai Charra	Rangauti	Balidum	Baman Cherra
2	Block		Chaumanu	Kanchanpur	Kumarghat	panisagar	Salema
3	No of Households	Nos	550	300	324	227	352
4	Population	Nos	2530	1500	1889	1200	1828
5	Electrified	Y/N	n	n	y	y	1
6	Electrified H H	Nos	0	0	80	3	40
7	Distance from Grid	Km	1	3	0	0	0
8	Total Land	Kani	1600	7230	1725	2900	7230
9	Cultivable Land	Kani	600	2410	950	650	1807
10	Forest Land	Kani	700	2410	0	0	5422
11	Community Land	Kani	0	0	2 5	3	6 5
12	Large Farmers	Nos	0	0	7	0	0
13	Medium Farmers	Nos	0	0	26	0	5
14	Small Farmers	Nos	6	100	77	0	100
15	Marginal Farmers	Nos	244	100	60	122	0
16	Electric Pumpset	Nos	0	0	0	0	2
17	Diesel Pumpset	Nos	1	2	1	0	0
18	Total Irrigated Area	Kani	25	50	300	0	25
19	Depth of Ground Water Table						
19a	Summer	ft	45	10	10	0	15
19b	Winter	ft	35	30	27	0	25
20	Crop Residues	Y/N	1	N	1	0	0
20a	Total Area Sown	Kani	200	300	1297 5	530	1807
20b	Avg Yield	Qtl/Kani	2 8	6	12 8	13 4	6
	Selected price	Rs/Qtl	400	300	1500	625	470
21	Ration Shop	Rs/lit	0	7	6	0	0
22	Source Distance	Km	0	22	8	0	0
23	Electric Domestic	Rs/Kwh	0	0	2 52	0	0
24	Fuelwood Twigs	Rs/Kg	0	0	5	0	0
25	Flour Mills	Nos	0	0	0	0	0
26	Rice Mills	Nos	0	0	0	0	2
27	Oil Processing	Nos	0	0	2	0	0

S No	Variables		Units					
	Gasification & briquetting							
I	Total crop residue available (1 25 of clean rice)		tonnes	70	225	2076	890	1360
II	Crop residue available for briquetting (0 75 of clean rice)		tonnes	42	135	1246	534	816
III	Total electricty that could be generated		kWhx10^3	30	98	900	400	600
IV	Required installed capacity to exploit the potential		@ 8 hrs/day, 365 days/year	10	35	310	135	205
V	Required electricity generation	Lighting		20 kW system 240 HH, 24 st lights,	25 kW, 300 HH & 30 st lights	25 kW, 244 HH, 24 st lights	20 kW, 224 HH 22 St lights	26 kW, 312 HH, 31 St lights
		Water lifting		No surplus available	20 kW(3 Nos), irrigates about 250 acres of land for one crop	20 kW (4 Nos), approx 260 acres irrigation	20 kW (4 systems), approx 260 acres irrigation for one crop/yr	20 kW (10 systems), approx 713 acres irrigation one crop/yr
VI	Surplus potential of electricity/briquettes through crop residue			Nil	Nil	800,000 kWh or 1100 tonnes	300,000 kWh or 400 tonnes	400,000 kWh or 552 tonnes

The possible end uses specific to the above villages

- Street lights
- Domestic lights
- Water lifting
- Flour mill
- Rice mill
- Oil processing
- Briquette making

Assumptions

- Lighting: Domestic load - 2 points per HH of 40 Watt each.
  Street lighting load - one street light for every ten households (one for each 100 meters), 4 to 5 hours per day lighting, 330 days per year is considered
- Irrigation load: Assuming irrigation will be required only one season (90 days).
  2 to 3 inch irrigation once in every 15 days is considered.
  One irrigation per acre is assumed to consume about 40 kWh of electricity

Note 2.5 kani = 1 acre

Conversion of crop residue to briquettes is taken as 100% since there is negligible waste in the process.

Briquette consumption to produce 1 kWh of electricity = 1.38 kilograms. This includes the "self consumption" of briquettes to produce briquettes.

Micro-hydel

Amongst the alternative energy sources in North Tripura district, micro-hydel has a substantial potential. It is the most appropriate source for large scale decentralized electrification in remote villages (most of the villages are situated along one or the other stream) But all the streams in the district are not perennial, and therefore, micro hydel systems cannot be installed on all of them. Department of Science, Technology and Environment of Tripura has identified a number of potential sites for mini-micro hydel in North Tripura district These sites are expected to generate sufficient electric power for the villages nearby. The identified sites are listed in the table below:

Table 6.32. Potential sites for mini/micro hydel plants in North Tripura

S No	Stream/charras	Location	Block
1	Karam Charra	Karam Charra	Chhamanu
1	Tuisema	Kanchanpur	Kanchanpur
2	Vangmun	Kanchanpur	Kanchanpur
1	Pabni Charra	Ranguti	Kumarghat
2	Nagashar Charra	Kailashsahar	Kumarghat
3	Saida Charra	Gokul Nagar	Kumarghat
4	Rata Charra	Purba Kanchanbari	Kumarghat
5	Phatick Charra	Kailasahar	Kumarghat
6	Lalguri Charra	Kanchanbari	Kumarghat
7	Dhakuti	Kailasahar	Kumarghat
8	Hariamuni Charra	Roja Para	Kumarghat
9	Dhanbilast Charra		Kumarghat
10	Kuki Charra	Kailasahar-Dharamnagar road	Kumarghat
11	Bet Charra	Purba Kanchanbari	Kumarghat
1	Ichailal Charra	Laxmipur	Panisagar
1	Daura Charra	Murabari	Salema
2	Saikarbari	Kamalpur	Salema
3	Nali Charra	Salema	Salema
4	Panchashi	Kamalpur	Salema
5	Pikrai Charra	near Manikbhandar Kamalpur	Salema

Capacity and investment

DSTE North Tripura district has identified 20 sites for micro-hydel Assuming capacity generation of each plant to be 400 kilowatt, for 20 plants it works out to be 8000 kilowatt. Assuming a plant load factor of 30%, a plant would generate electricity for 7.2 hours At this rate total electricity generated from 20 plants would be 57,600 kilowatt hour/day or 57 6 megawatthour/day This electricity generated can feed approximately 40,000 households.

Assumptions made to calculate requirement of electricity per household are

- 4 bulbs per household
- 6 hours daily usage
- 60 watt each bulb

Total demand for electricity per household would be

= 4x6x60 = 1440 watthour per day or 1.44 kwh/day/household

Total electricity produced from 20 mini-micro hydel plants = 57,600 kWh
No. of households electrified = 57600/1.44 = 40,000
Approximate cost for 20 mini-micro hydel plants at the rate of Rs. 400 lakhs per plant works to be Rs. 8000 lakhs

Solar photovoltaic systems

The solar photovoltaic programme has been very successful in North Tripura district Under this programme remote and isolated villages have been electrified to meet the requirement of lighting for family as well as for community and street lighting Villagers have been provided with domestic lights through SPV programme, besides which television sets and solar operated clocks have also been disseminated Most of the SPV systems have been installed in the Jampai hills which is the extension of the Mizo hills in the North Tripura district. These systems are used mainly for lighting in the domestic sector and churches

There is a vast potential for SPV in this region which is yet to be tapped Mean sunshine hours per day, available in different months which was recorded at Agartala is given in the table below

Table 6.33. Average monthly sunshine hours per day in Tripura

Months	Hours
January	7.3
February	8 2
March	7 6
April	7 8
May	7 6
June	3 2
July	4 5
August	4 6
September	5 6
October	7 2
November	8 0
December	7 3

As observed from the above data, the sunshine hours are maximum during October to May and are least during the months of June to August On average the total sunshine available in an year is **2400** hours So the percentage of total sunshine hours in a year is 2400/8760 = **27.83 %** It can be inferred that sufficient sunshine is available for almost nine months in a year, enough to run the solar systems efficiently

The most potential photovoltaic devices for the district are solar power packs and solar lanterns for lighting There is also scope for photovoltaic water pumping systems, especially for irrigation However, proper assessment of the suitability of such a system is advisable before installing any Another major use for SPV in the district can be communication. North Tripura district has a sensitive law and order situation and it is possible to use solar systems to run wireless transmission sets to have better accessibility to the remote villages

Therefore, in order to exploit the potential existing for the solar devices, it is not only necessary to conduct specific feasibility studies in specific regions, it is also important to launch educational campaigns to create awareness among the people Likely benefits from the proposed energy interventions

Given the different energy intervention options worked for different blocks village-wise, an attempt has been made to compute the likely fuel replacement and the reduction in the use of biomass fuels.

Table 6.34. Energy demand estimation - Chhamanu block

Variables	Total	I	II
Total HHs Surveyed	195	27	167
Surveyed population	1024	143	881
Total HHs (1991)	17295	1503	15792
Total HHs (2001)	22400	1946	20453
		Electricity	
Electricity consumption (1993) '000 kWh/day	7.58	0.66	6.92
Electricity demand (2001) '000 Kwh/day	9.82	0.85	8.97
		Firewood	
Cooking+waterheating (kg\hh\day)			
Firewood consumption (1993) tonnes/day	259	27	232
Firewood demand (2001) tonnes/day	335	35	300
Fuelwood demand after disseminating improved devices tonnes/day	295		
Space heating (kg\hh\day)			
Firewood consumption (1993) tonnes/day	53	7	46
Firewood demand (2001) tonnes/day	68	9	60
		Kerosene	
Lighting (litres\month\hh)			
kerosene consumption (1993) '000 Litres	50	6	44
Kerosene demand (2001) '000 liters	65	8	56

Table 6.35. Energy demand estimation - Kumarghat block

Variables	Sum	I	II
Total HHs surveyed	134	8	126
Surveyed population	701	40	661
Total HHs (1993)	25926	980	24946
Total HHs (2001)	33578	1270	32309
		Electricity	
Electricity consumption (1993) '000 kWh\day	8.85	0.43	8 42
Electricity Demand (2001) '000 kWh\day	11.46	0 56	10.90
		Firewood	
Cooking+waterheating (kg\day hh)			
Firewood consumption (1993) tonnes/day	196	8	188
Firewood demand (2001) tonnes/day	254	10	243
Fuelwood demand after disseminating improved devices tonnes/day	224		
Space heating (kg\day\hh)			
Firewood consumption (1993) tonnes/day	10	0	10
Firewood demand (2001) tonnes/day	13	0	13
		Kerosene	
Lighting (litres\month\hh)			
Kerosene consumption (1991) '000 litres	87	6	80
Kerosene demand (2001) '000 litres	112	8	104

Table 6.36. Energy demand estimation - Salema block

	Sum	I	II
Total HHs surveyed	143	15	128
Surveyed population	752	79	673
Total HHs (1991)	26413	1626	24787
Total HHs (2001)	34210	2106	32103
		Electricity	
Electricity consumption (1991) '000 kWh/day	9.08	0.71	8.36
Electricity demand (2001) '000 kWh/day	11 76	6.92	10.83
		Firewood	
Cooking+waterheating (kg\day\hh)			
Firewood consumption (1993) tonnes/day	362	22	340
Firewood demand (2001) tonnes/day	469	28	440
Fuelwood demand after disseminating improved devices tonnes/day	413		
Space heating kg\day\hh			
Firewood consumption (1993) tonnes/day	70	4	66
Firewood demand (2001) tonnes/day	91	5	85
		Kerosene	
Lighting (litres\month\hh)			
Kerosene consumption (1991) '000 litres	119	6	114
Kerosene demand (2001) '000 litres	154	7	147

Table 6.37. Energy demand estimation - Kanchanpur block

Variables	North Tripura	I Order	II Order
Total HHs surveyed	182	33	149
Surveyed population	958	173	785
Total HHs (1991)	19913	4760	15153
Total HHs (2001)	25791	6165	19625
		Electricity	
Electricity consumption (1993) '000 kWh/day	7 20	2.09	5 11
Electricity demand (2001) '000 kWh/day	9 33	2 70	6.62
		Firewood	
Cooking+waterheating (kg\day\hh)			
Fuelwood consumption (1993) tonnes/day	221	48	173
Fuelwood demand (2001) tonnes/day	286	62	224
Firewood demand after disseminating improved devices tonne/day	252		
Space heating (kg\day\hh)			
Fuelwood consumption (1993) tonnes/day	33	11	23
Fuelwood demand (2001) tonnes/day	43	14	30
		Kerosene	
Lighting (litres\month\hh)			
Kerosene consumption (1993) tonnes/day	79	14	65
Kerosene demand (2001) tonnes/day	103	18	85

Table 6.38. Energy demand estimation - Panisagar block

Variables	Sum	I	II
Total HH	72.00	9.00	63.00
Total pop	381.00	49.00	332.00
Total HH 1991	6120	342	5778
Total HH 2001	30863	1728	29135
		Electricity	
Electricity consumption (1993) '000 kWh/day	2.10	0 15	1.95
Electricity demand (2001) '000 kWh/day	2 72	0.19	2.53
		Firewood	
Cooking+waterheating (kg\day\hh)			
Fuelwood consumption (1993) tonnes/day	74.23	2 90	71.33
Fuelwood demand (2001) tonnes/day	96 13	3 76	359.52
Fuelwood demand after disseminating improved devices tonnes/day	84 6		
Space heating (kg/day/hh)			
Fuelwood consumption (1993) tonnes/day	12 28	0.27	12 01
Fuelwood demand (2001) tonnes/day	15 91	0.34	15.56
		Kerosene	
Lighting (litres\month\hh)			
Kerosene consumption (1993) '000 litres	21 37	1.33	20.04
Kerosene demand (2001) '000 litres	27.68	1.72	25.95

Table 6.39. Energy demand estimation - North Tripura district

Variables	North Tripura	I	II
Total HHs surveyed	726	92	633
Surveyed population	3816	484	3332
Total HHs (1993)	95668	9211	86456
Total HHs (2001)	123905	11930	111974
		Electricity	
Electricity consumption (1993) '000 kWh/day	34 81	4.04	30 77
Electricity demand (2001) in '000 kWh/day	45 08	5 23	39 85
Electricity generated through micro-hydel in '000 kWh/day	57 6		
Percentage saving	32 28		
		Fuelwood	
Cooking+waterheating			
Fuelwood consumption (1993) tonnes/day	1112	108	1004
Fuelwood demand (2001) tonnes/day	1440	139	1300
Fuelwood demand after disseminating improved devices tonnes/day	1267		
Percentage fuelwood saving	12		
Space heating			
Fuelwood consumption (1993) tonnes/day	178	21	157
Fuelwood demand (2001) tonnes/day	231	28	203
		Kerosene	
Lighting			
Kerosene consumption (1993) '000 litres	357	34	323
Kerosene demand (2001) '000 litres	462	44	418

Table 6.40. Energy demand estimation - Salema block (Revised)

	Sum	I	II
Total HHs surveyed	143	15	128
Surveyed population	752	79	673
Total HHs (1991)	26413	4626	24787
Total HHs (2001)	37655	2318	35337
		Electricity	
Electricity consumption (1991) '000 kWh/day	9.08	0.71	8.36
Electricity demand (2001) '000 kWh/day	12 94	1 02	11.92
		Firewood	
Cooking+waterheating (kg\day\hh)			
Firewood consumption (1993) tonnes/day	362	22	340
Firewood demand (2001) tonnes/day	516	31	485
Fuelwood demand after disseminating improved devices tonnes/day	454		
Space heating kg\day\hh			
Firewood consumption (1993) tonnes/day	70	4	66
Firewood demand (2001) tonnes/day	100	6	94
		Kerosene	
Lighting (litres\month\hh)			
Kerosene consumption (1991) '000 litres	119	6	114
Kerosene demand (2001) '000 litres	170	8	162

Note Some villages of block Salema had been reformed in 1991 census which were not existent in the 1981 Census This information was not available during the field trip in the district Therefore there are two different tables for energy demand estimation for the year 2001. Information for energy demand estimation in the first table is based on the population of old villages and in the second table (revised) energy demand estimation is computed including new formed villages

Table 6.41 Energy demand estimation - Panisagar Block (Revised)

	Sum	I	II
Total HHs surveyed	72	9	63
Surveyed population	381	49	332
Total HHs (1991)	6120	342	5778
Total HHs (2001)	30863	1728	29135
		Electricity	
Electricity consumption (1991) '000 kWh/day	2 10	0 15	1 95
Electricity demand (2001) '000 kWh/day	10 59	0.76	9 83
		Firewood	
Cooking+waterheating (kg\day\hh)			
Firewood consumption (1993) tonnes/day	74 23	2 90	71 33
Firewood demand (2001) tonnes/day	374 30	14 66	359 64
Fuelwood demand after disseminating improved devices (tonnes/day)	329 38		
Space heating kg\day\hh			
Firewood consumption (1993) tonnes/day	12 28	0 27	12 01
Firewood demand (2001) tonnes/day	61 93	1 34	60 58
		Kerosene	
Lighting (litres\month\hh)			
Kerosene consumption (1991) '000 litres	21 37	1 33	20.04
Kerosene demand (2001) '000 litres	107 77	6 72	101.05

Note· According to 1981 census for North Tripura district there were 45 villages in Panisagar block But information regarding landuse and demography for Panisagar is available only for first 31 villages Therefore energy demand estimation for the block includes population of 31 villages only. Except for data on demography, village-wise landuse information was not published for the year 1991 Therefore for projecting population for the year 2001, proportional population distribution in 1st and 2nd order settlements of 1991 have taken and energy demand was estimated accordingly

Table 6.42 Energy demand estimation - North Tripura District (Revised)

	Sum	I	II
Total HHs surveyed	726	92	633
Surveyed population	3816	484	3332
Total HHs (1991)	95668	9211	86456
Total HHs (2001)	150287	13427	136859
		Electricity	
Electricity consumption (1991) '000 kWh/day	34.81	4.04	30 77
Electricity demand (2001) '000 kWh/day	54	6	48
Generation of electricity from micro-hydel '000 kWh/day	57 6		
		Firewood	
Cooking+waterheating (kg\day\hh)			
Firewood consumption (1993) tonnes/day	1112	108	1004
Firewood demand (2001) tonnes/day	1765	153	1612
Fuelwood demand after disseminating improved devices (tonnes/day)	1553		
Percentage fuelwood saving	12		
Space heating kg\day\hh			
Firewood consumption (1993) tonnes/day	178	21	157
Firewood demand (2001) tonnes/day	286	29	257
		Kerosene	
Lighting (litres\month\hh)			
Kerosene consumption (1991) '000 litres	357	34	323
Kerosene demand (2001) '000 litres	557	49	508

CHAPTER 7

Implementation of energy plan

The four-decade experience in the field of rural development in India has illustrated that most problems faced in execution of the programmes could be attributed to either deficiencies in planning (insufficient infrastructure, inadequate fund allocation, etc), or the methods of implementation This has been particularly true for decentralised energy technology dissemination efforts as has been shown by the initial feedback from National Project on Biogas Development (NPBD), National Programme for Improved Chulha (NPIC), etc However, efforts to study the existing implementation structure and design an effective mechanism to improve the process have been largely absent from most of the energy planning exercises in the past However, if the energy plan has to be successfully implemented and reach the projected benefits to the people, it is important to study the implementation aspects, and this assumes added significance in the case of a remote and relatively inaccessible district like North Tripura Therefore, the existing structure for implementing various programmes in the district have been examined, and some possible mechanisms to facilitate better implementation have been suggested in the present chapter

Institutional structure

Presently, there is a multiplicity of organisations involved in promoting and implementing different programmes related to energy at the district level The list of agencies responsible for various programmes is given in table 7 1

Table 7.1. Agencies involved in energy supply/development in North Tripura

Fuel/technology	State nodal organisation	Other agencies involved
Electricity	Power Department	-
Diesel/Petrol	Oil companies	District Collector, Wholesalers
Kerosene	Food Department	Fair Price Shops, Wholesalers, Oil companies
Biogas	Agriculture Department	KVIC, Lead Bank, DRDA, BDOs
Renewable energy technology programmes*	Department of Science, Technology and Environment	District Collector
Energy plantation	Forest Development and Plantation Corporation	-
Small Hydro	Power Department	DSTE

*Includes improved chulhas, solar photovoltaics, solar thermal systems, wind, bio-energy, mini-micro hydel, urjagram and IREP

As can be seen from the table, except for the renewable energy programmes, the rest are all implemented by different organisations at various levels with little coordination among themselves which often results in system losses For instance, if targets for different technologies/programmes in a particular geographical unit are determined in an integrated manner instead of exclusive targets, it would be possible to ensure a proper 'fit' between the demand and supply. In order for this to occur, two possible mechanisms are suggested one, to create a coordinating body at the district level having members from all the relevant organisations whose purpose would be to ensure a holistic approach to implementation of such plans It is important to involve both government and non-government organisations in such a body as NGOs, given their proximity to the grassroots, would be able to make a significant contribution Such a body could be constituted under the chairmanship of the District Collector who enjoys the benefit of an overall development perspective as far as the district is concerned The second mechanism would be to identify a 'link-pin' organisation at the district level which can ensure coordination among all the involved agencies, and monitor the progress of the entire activity For instance, DSTE, the nodal agency for the renewable energy technologies at the state level, could be considered to be the 'link-pin'

organisation as it is the most prominent among all the organisations involved However, for this, DSTE would have to expand its infrastructure and man power at the district level, which is presently confined to one assistant engineer and a few field staff

Implementation aspects

As is shown in table 7 2 below, the total allocation in the VIII Plan (1992-97) for promotion of energy programmes in the state of Tripura is Rs 5 75 crores, which is quite low compared to other development programmes -- Power Department, for instance, has an allocation of Rs 170 crores Of this amount, only about one-third to one-half is likely to be invested in North Tripura district On the other hand, the investment requirements projected in the energy plan (chapter 6) are high Therefore, it is imperative to mobilise additional resources for successful implementation of the energy plan.

Table 7.2 VIII Plan allocation for energy sector in Tripura

Programme	Allocation (Rs lacs)
Energy planation	60
Microhydel	30
Improved chulhas	20
Biogas and gasifier	80
Wind	10
Solar thermal programme	30
Solar photovoltaic programme	130
Urjagram	10
Low lift handpump	2
Energy education	8
Administration and miscellaneous	195

Source Draft Eighth Plan 1992-97, Vol II, Government of Tripura

One of the effective ways of doing this would be to integrate various energy programmes with the general development programmes For instance, there are specially designed programmes with separate administrative infrastructures for different activities as shown in table 7.3.

Table 7.3. Different development programmes in North Tripura

Agency/Programme	Activities
Integrated Rural Development Programme (IRDP)	Rural employment, drinking water and sanitation, housing
Integrated Rural Energy Planning Programme (IREP)	Energy plantation, extension of LT lines, renewable energy promotion
Border Area Development Programme (BADP)	Social forestry, drinking water supply
Tribal Areas Autonomous District Council (TAADC)	Irrigation, water supply, forestry, power

Source: Draft Annual Plan 1993-94, Vol III, Government of Tripura

In order to take advantage of various development programmes implemented in the district, energy technologies can be made part of these programmes For instance, photovoltaic pumping systems can be installed under IRDP, BDAP and TAADC to provide irrigation as well as drinking water, energy plantations and improved chulhas could be part of the social forestry activities of BDAP, micro hydel systems could be part of decentralised power generation programme of TAADC and IREP[6], biogas plants and improved chulhas can be made integral part of the housing design, wherever technically feasible, under the rural housing programme of IRDP, and, energy dissemination activities can generate rural employment under SREP, TRYSEM, Jawahar Rozgar Yozana, etc

The advantage of actively pursuing such an holistic approach would be two-fold firstly, energy programmes can be promoted using the additional resources available under the development programmes, and secondly, such an integration of energy development with overall development would take people's felt needs into account improving the chances of the acceptance of different technologies With the recent promulgation of the Panchayati Raj Bill which aims to empower the local institutions and local people, such an approach would assume a greater significance and relevance

[6]Another major source could be Rural Electrification Corporation (REC)

Support infrastructure

One of the major pre-requisites for a successful and sustained energy intervention programme is the existence of an adequate supporting structure Often, most well-planned and well-intentioned interventions have eventually failed for want of good support Therefore, it is imperative to consider the following aspects

Training

One of the major shortcomings in making the energy technologies function has been lack of proper training for the people who construct and install them, and also for the beneficiaries who use the systems Therefore, it is recommended that a fullfledged centre be set up at the district headquarters to take care of different types of requirements like technical training, user education, motivational training, etc This centre could be designed on the lines of the Panchayat Training Institute that already exists at the state level. The centre would not only impart training but also could be used as a demonstration centre for various technologies

Maintenance

It has been a common experience in energy development activities that systems remain dysfunctional for lack of simple maintenance and spareparts Therefore, it is important to create accessibility for the users to go in for repairs and modifications when necessary so as to reduce the downtime of the technology systems Hence, it is recommended that a well-equipped and well-manned service centre be opened at the district level which could cater to the needs of operation and maintenance This centre could be part of the aforementioned integrated training centre Such a centre could also disseminate information and provide publicity on the merits of various energy systems

Thus, an integrated support centre that could cater to training, information and operation and maintenance needs would go a long way in ensuring implementation of the energy plan and success of the interventions in various sectors

Annexure - I

Village schedule

Village _____
Block_____

A. General Particulars

1 No. of households _____ 2. Total population_____
3 No of school going children_____ 4. Electrified Yes/No
5 No of electrified household _____ 6. Major tribal groups _____

B. General Characteristics

Distance from the block _____ Distance from the main road _____
Distance from the nearest Grid _____ Distance from nearest market _____
Distance from nearest bus stand _____ Nearest railway station _____
Road connecting the village with main road (metalled/unmettaled)
No of schools (P/M/S) _____
Post office (Yes/No) Hospital/Dispensary (Yes/No), Bank (Yes/No)
Veterinary hospital (Yes/No) Kerosene depot/FPS (Yes/No)

C. Land Particulars

a Land distribution (in acres)

Total land _____ Cultivable land _____ Forest Land_____
Community land _____ Pastures land _____ Barren land_____
Orchard land _____

b Land ownership pattern (No of families)

Large farmers (> 10 acres) _____ Medium farmers (5-10)_____
Small farmers (2 5-5) _____ Marginal farmers (<2 5)_____
Landless _____

D. Water particulars

(i) Drinking water

	Yes/No	Number
Well		
Hand pump		
Tap		
Tubewell		
Stream		
Tank		

Distance travelled to fetch drinking water presently (metres) _____
Distance travelled to fetch drinking water in the past (metres) _____
Mode of travel for collecting water _____ Time taken ____

(ii) Water for irrigation

Well_____ River____ Tank_____ Stream_____
Canal_____ Electrical_____ Diesel pumpset_____

(iii) Total irrigated area (in acres) _____

(iv) Depth of ground water table (ft) Summer_____ Winter_____

E. Livestock Particulars (in numbers)

Bullocks
Buffaloes
Cows
Calves
Goats
Sheep
Others (specify)

F. Sources of Energy

(a) Which of the following direct energy sources do you use in the village ? (Yes/No)

Firewood logs _____ Firewood twigs/branches_____
Crop residues _____ Dung cakes _____ Coal _____
Kerosene _____ Petrol _____ Electricity _____
Soft coke_____ Diesel _____ Charcoal _____
Human power _____ Animal power _____ Any other _____

(b) Which of the indirect energy sources are used ? (Yes/No)

Urea _____ DAP_____
Manure_____ Others_____

G. Cropping pattern

(a) Rabi crops

Crop	Season (from)		
	Total area sown	Average yield (Qtl/unit	Selected price

(b) Kharif crops

Crop	Season (from)		
	Total area sown	Average yield (Qtl/unit	Selected price

(c) Mixed crops

Crop	Season (from)		
	Total area sown	Average yield (Qtl/unit	Selected price

H. Mechanical Equipments

Number

Tractor

Thresher

Harvester

Motor Cycles/Scooters

Truck

Cycles

Bullock Carts

others (specify)

I. Energy Price Data

Fuel	Price		Source distance (kms)	Remarks
	Ration shops	Other shops		
Kerosene/lit				
Diesel/lit				
Petrol/lit				
Electric domestic/kwh				
Electric agriculture/kwh				
Fuelwood (twigs)/kg				
Dung cakes/pieces*				
Coal/kg				
Soft coke/kg				

* weight of a dry dung cake = _____ kgs

J. Small Industries

No _____ Capacity (H P) _____

Flour mills

Rice mills

Oil processing

Sugarcane processing

Furniture shop

Smithy

Others (specify)

K. New and Renewable Energy Devices Awareness

Natural gas

Biogas plants

Wind mill

Improved chulhas

Solar photovoltaic systems

Solar thermal devices

Others (specify)

L. General Development Priorities

What facilities would you like in your village ?
(Kuccha/Pakka houses, type of employment, etc)

Order of priority

1
2
3
4
5

Any other suggestions

M. Checklist of Questions on Feasibility of Technological Introduction

1 Micro hydel
2 Hydrams
3 SPV (lighting)
4 SPV (water pumps)
5 Natural gas

N. Jhum Cultivation

1 Is there any practice of Jhum cultivation around the village ? Yes/No
2 If yes, what is the quantity of land used for Jhum ?
3 What is the probable cycle for Jhum cultivation ?
4. Average number of people involved in Jhum ?
5 What Jhum crops are grown ?

O. Special Observations and Comment

Annexure - II

Household schedule

A. Household details

1. Name of the head_____
2. Electrified (Y=Yes, N=No) _____
3 Family size Men _____ Women _____ Children_____
4 Primary occupation _____
5. Secondary occupation _____
6 Month in which employment not available _____
7 Do you go outside village for employment ? Yes/No If yes where?_____
Distance_____

B. Food consumption and cooking methods

1 Average monthly per-household consumption of (in kg)
Rice _____ Wheat _____
Pulses_____ Others_____
Cooking habits_____
2 Average daily per-household of milk _____
2a Consumption (kg) _____ 2b Sale _____ 2c Price (Rs/Kg)_____
3 Time spent in cooking daily hours_____
4. Type of utensils used (with type of materials)_____
5 Is cooking inside the kitchen (Y=Yes, N=No) _____
5a Number of months cooking inside _____
Number of months cooking outside _____

5b. Chulhas or cookstoves particulars

Chulhas	Types of energy source used	What is the cost of the device	Monthly energy expenditure (Rs) per household
1			

6 How many hours do you use the chulha for cooking in

Summer _____ Winter_____

7 How many hours do you use the chulha for water heating

Summer _____ Winter_____

8 What is your monthly electricity bill during

Summer (Rs)_____ Mansoon (Rs)_____ Winter (Rs)_____

9 How many hours per day to you see lighting device (hrs/day)_____

9a What are the use for lighting ? Study _____ General _____

9b How many bulbs_____ lanterns_____ diya _____ do you have?

10 What is your monthly kerosene consumption during

Summer (Rs) _____ Mansoon (Rs) _____ Winter (Rs)_____

11 How many hours do you use for space heating un Summer _____ Winter_____

C. Land ownership

1 Total agricultural land (acres) _____

2. Good agricultural land (acres) _____

3 No. of pieces _____

4 Area irrigated (acres _____

4a Source of irrigation _____

D. Livestock statistics (Households)

Type of animals	Total No.	Stallfed	Grazing area (km)	Daily milk production (kg/animal)
Cows				
Calves				
Bullocks				
Buffaloes				
Goats/Sheep				
Others (Specify)				

E. Domestic Consumption

Fuel type	Unit	Cooking + Water heating			Space heating			Lighting			Total		
		S	W	M	S	W	M	S	W	M	S	W	M
Dung cake	Nos/day												
Firewood.log	Kg/day												
Twigs/branches	Kg/day												
Crop residue	Kg/day												
Electricity	kwh/month												
Kerosene	lit/month												
Coal	Kg/month												
Others													

F. Collection and preparation of biomass

Collection of wood

Particulars	Summer	Monsoon	Winter
No of persons collecting			
No of collecting days per week			
No of trips made by one person in a day			
Total quantity collected per person per trip (kg)			
Distance travelled per trip for collection (km)			
Collection source (type of land)			

G. Dung information

(i) Is dung used for fuel ? Yes/No
(ii) If yes, total number of dungcakes made per day _____
(iv) Average weight of dry dungcake (kg) _____

H. Non-energy regular uses of biomass

Biomass	Construction	Agricultural implements	Furniture	Plastering (for dung)	Any export outside the village	Any other
Firewood						
Dung						
Agri residues						

I. Family income generated from various sources

Primary _____ Secondary _____ Any other _____

Total expenditure (Rs/month) _____ Total income (Rs/month)_____

J. Scarcity indicators

1 Do you perceive fuel wood scarcity ? Yes/No

2a. Does the present firewood consumption vary from the post ? Yes/No

2b If so, has it increased/decreased ? Increased/decreased

3 Has the no of persons collecting gone up ? Yes/No

By how many ?

4 Has the no of collection trips per week gone up ? Yes/No

5 Whether fuel is purchased/collected for special requirements (festivals, marriages ?)

K. Agricultural energetics for one cycle of crop production

[Please report for the crops you had grown in the last one year in different seasons]

Description	Rabi	Khariff

Crop particulars

1 Crops grown (types)

2 Productivity (kg/acre)

3 Total no of days _____

animal used (own/rented)

4 Total number of mandays

Self

Labour

5 No of hours motor used

H P of motor

Own/rented

Amount spent

Diesel/electric pumpset

1. H P. of the pumpset
2. Average time spent/day (hrs/day)
3. Total number of days used (days)
4 Total diesel/electric consumption (Rs/season)

L. Grazing practices

1 Does a family member take the cattle out ? Yes/No

2 If no

M. Fuel preference

(a) What fuel would you like to use for cooking

Cooking

Lighting

Irrigation

(b) Is natural gas available in the vicinity ?

Would you like to use it for

Cooking

Lighting

Irrigation

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Table 5.1 Annual Plan 1992-93 (Rs in crores)

S No	Sector	Proposed by the state	Recommended by the working group	Approved outlay
1	Agriculture and allied services	55 42 (15 37)	51 06 (17 06)	68 85 (24 41)
2	Rural development	21 99 (6 09)	61 62 (5 55)	16 36 (5 80)
3	Special area programme	51 85 (14 38)	21 57 (7 20)	19 50 (6 93)
4	Irrigation and flood control	25 05 (6 94)	24 61 (8 22)	20 25 (7 18)
5.	**Energy**	**37.18** **(10.31)**	**37.60** **(12.56)**	**35.00** **(12.41)**
6	Industry and minerals	22 11 (6 13)	17 00 (5 71)	17 00 (6 02)
7	Transport	33 34 (9 24)	33 23 (11 10)	22 25 (7 89)
8	Communication	0 36 (0 09)	0 30 (0 01)	0 30 (0 10)
9	Science, Technology and Environment	1 36 (0 37)	0 86 (0 02)	0 86 (0 30)
10	General economic services	2 50 (0 69)	1 82 (0 60)	1 82 (0 64)
11	Social services	106 41 (29 51)	91 61 (30 60)	77 74 (27 26)
12	General services	2 94 (0 81)	2 94 (0 98)	2 00 (0 70)
	Total	360 51	299 32	282 00
	Note Figures in parentheses are percentages			

Source Annual plan, 1992-93, Directorate of planning, Govt of Tripura

As can be seen, about Rs 35 crores has been allocated for the energy sector intended mainly for solar PV programme, biogas programme smokeless *chulha* and energy plantations In terms of physical target and total achievement in the energy sector, it can be seen from table 5 2 that major emphasis is on afforestation, plantation in the catchment area where trees are uprooted due to floods

Table 5.2 Physical target and achievement of government plan

Sector	Unit	Total achievement		1991-92 (anticipated)	Target 1992-93	Target 1992-93		Target for North Tripura district
		Upto 1989-90	1990-91			TSP area	SCP area	
Forestry								
1 Plantation of quick growing species	ha	1943	1150	987	1000	600	75	400
2 Economic and commercial users	ha	11602	2 520	2 200	2 500	1,700	175	840
3 Social forestry	ha	21936	7 510	3 891	3 500	2,550	250	11875
Afforestation								
1 Tree planted	No	1260	280	240	260	182	20	116
Production of selected products								
1 Timber	'000 cu m	206 547						
2 Firewood	'000 cu m	486 963						
3 Bamboo	'000 cu m	211,126						
Soil Conservation								
1 Plantation on catchment areas	000 ha	5312	1335	1280	1000	720	20	550
IREP								
1 NREP	Mandays (lakh)	42 779						
2 RLEGP	Mandays (lakh)	35 435						
3 SREP	Mandays (lakh)	132 228	33 30	24 310	26 25	9 18	3 93	8 53
4 JRY	Mandays (lakh)	9 537	19 079	8 921	5 117	1 79	0 77	1 790
Bio-Energy Programme								
1 Biogas plants	No	91	45	60	12	30	6	
2 Gasifier	No	1		2	2	2		

Sector	Unit	Total achievement		1991-92 (anticipated)	Target 1992-93	Target 1992-93		Target for North Tripura district
		Upto 1989-90	1990-91			TSP area	SCP area	
Solar PV programmes								
1 Solar pumps	No	80	12	16	20	4	10	4
2 (a) Solar PV system	Villages	46	18	10	10	8	2	6
(b) Solar lanterns	Villages	--	--	--	2	2	--	--
3 Solar TV	No	40	18	25	25	20	4	10
4 Solar clock	No	12	1	--	10	8	--	4
5 Solar power plants	No	3	1	--	--	--	--	--
Solar thermal programme								
1 Solar hot water system	Litres	5	--	1000	4000	--	--	--
2 Solar distillation plants	No	20	--	--	3	--	--	--
3 Solar drier	No	4	--	--	2	--	--	--
4 Solar cooker	No	--	--	--	10	--	--	6
Wind energy programme								
1 Wind generator	No	3	--	1	--	--	1	--
2 Collection of data for wind mapping	centers	2	10	10	--	--	4	3
3 Wind pumping system	No	4	--	--	--	--	--	--
Low lift hand pump	No	20	--	10	--	--	5	2
Smokeless chulha	No	4505	1610	2500	1000	1000	1000	1000
Rural energy centre	Village	4	--	1	1	--	1	--
Energy forestry	Ha	120	120	470	70	67	--	--
Micro hydel projects	No	--	--	1	--	--	--	--

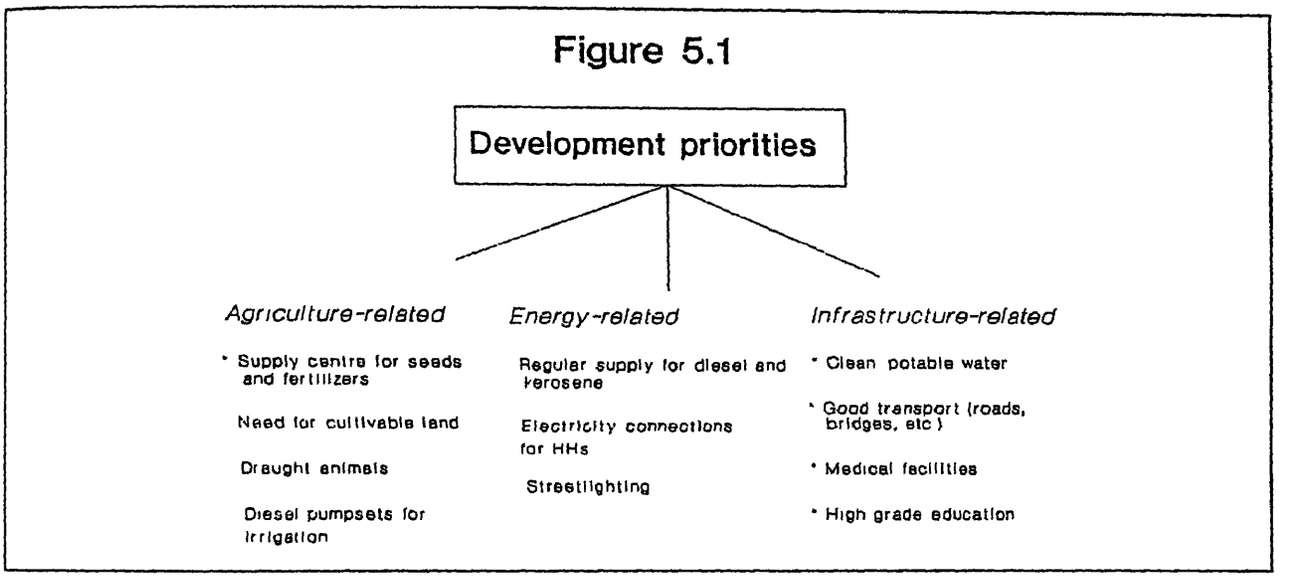
Source Annual Plan, 1992-93, Directorate of planning, Govt of Tripura

People's perceptions

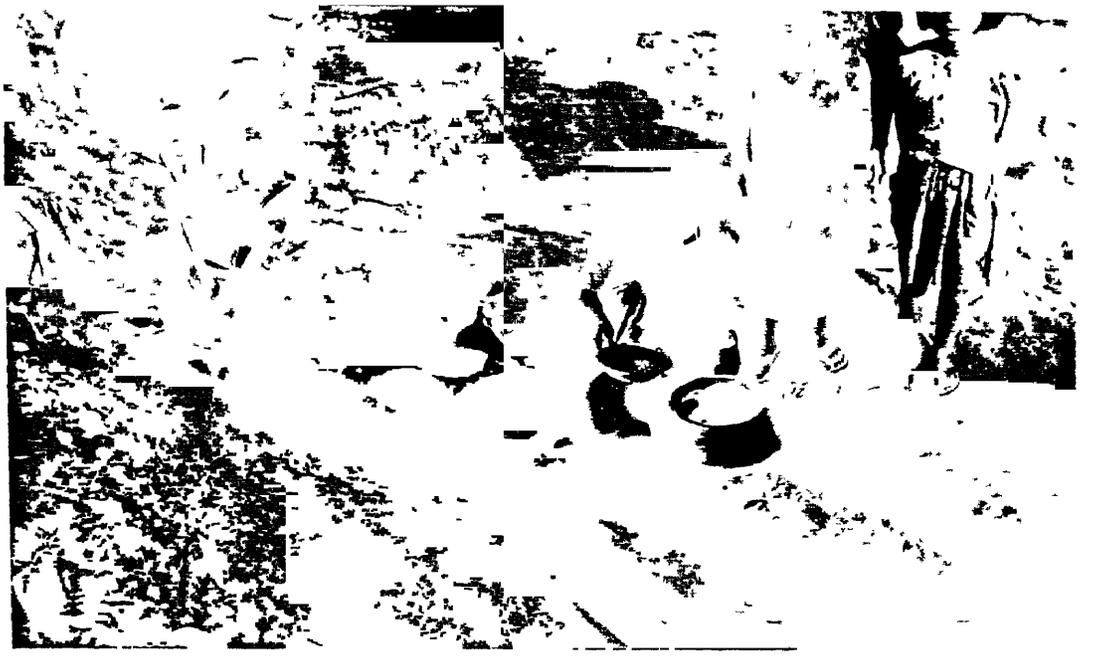
The development priorities as perceived and articulated by the people have varied across the district, depending on the particular needs of a class and the part of the district they inhabit For landless and the marginal farmers with meagre sources of livelihood for a major part of the year, finding regular employment had been the first priority all over the district Irrigation and drinking water was also one of the top priorities mentioned by

the people from all parts of the district The general list of priorities as perceived by the people has been illustrated in figure 5 1

Figure 5.1 People's perceptions on development priorities



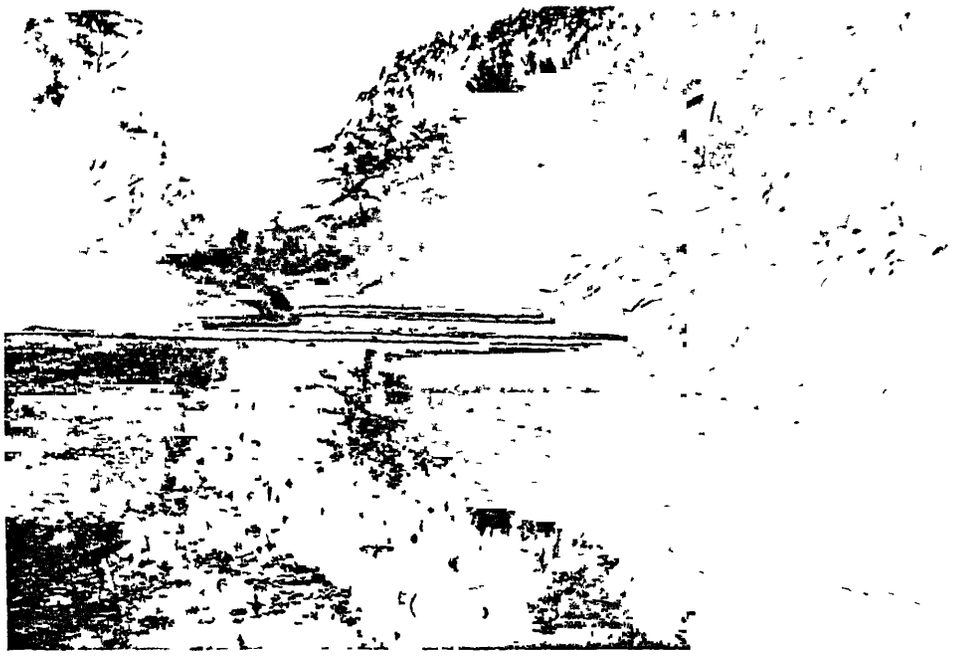
Though most of the needs enumerated in the above matrix are common to most parts of the district, there is a clear pattern that correlates the articulation of a specific need to specific region or groups of people For instance, the major demand for regular supply of seeds, fertilizers, and diesel pumpsets came from areas in Kanchanpur and Chhamanu blocks which are major cultivation areas, while demand for more cultivable land was voiced in the tribal blocks of Chamannu and Kanchanpur where *jhum* cultivation has become unsustainable Similarly, potable water is a major concern in these two blocks where water has high mineral content That good transportation system has a strong correlation to the development process is evident from the difference between villages which were inaccessible, and those which enjoyed good access by having bridges across the streams, etc



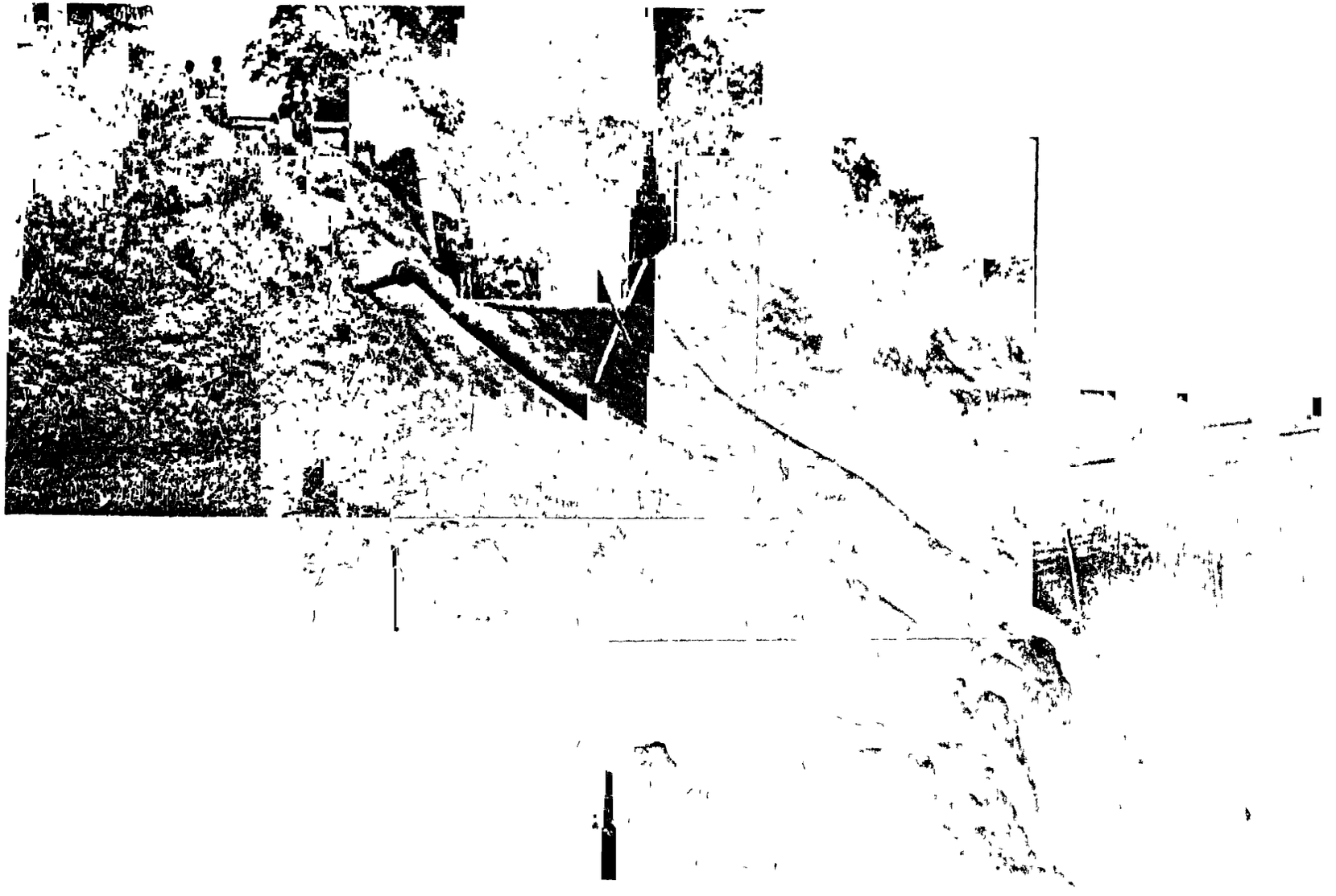
Women collecting water at a source in Jumpai Hills

Drinking water problem in Jumpai hills

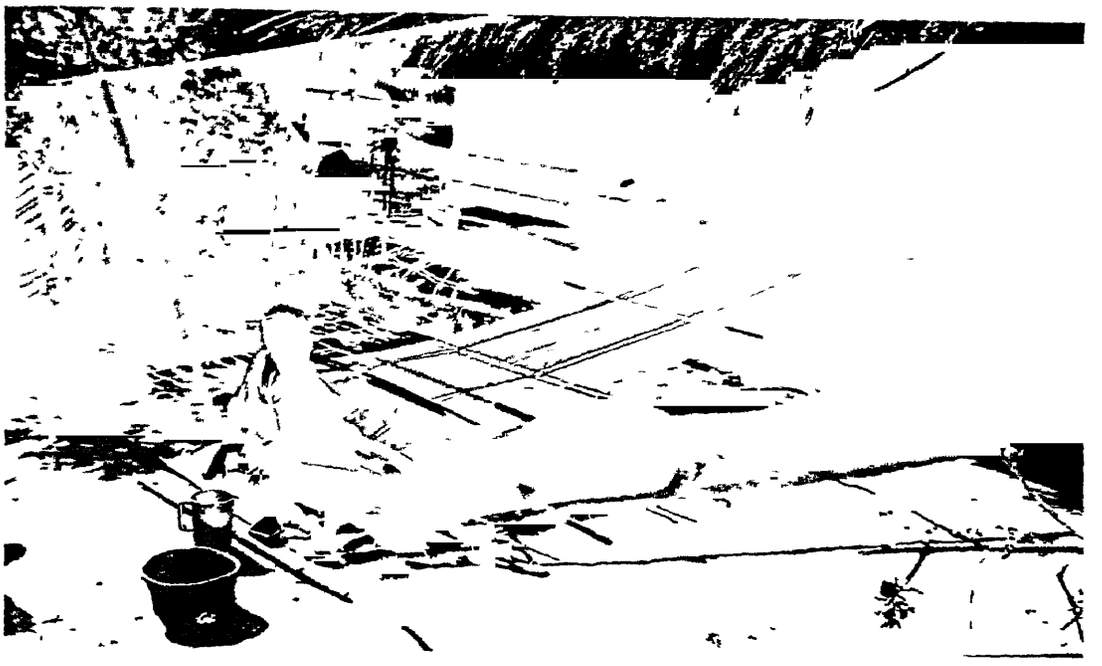
Kutcha well, mostly commonly found in the households



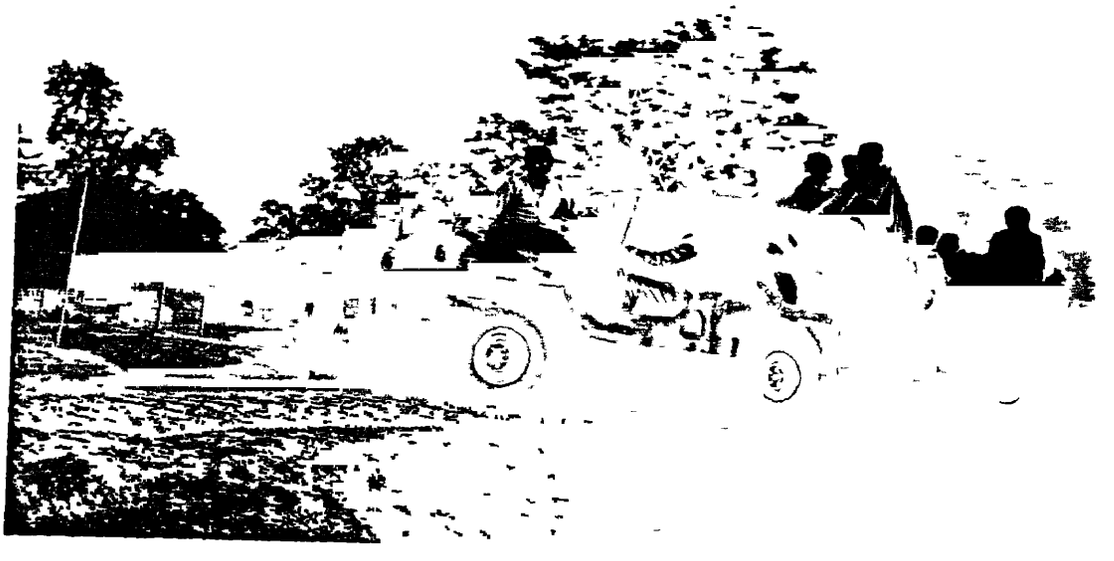
" Lunga land" locked from all sides by " Tılla land" (small hillocks)



Electric powered irrigation pumpset -- Block Salema



Local handicrafts by tribal families -- Block Chhamanu



Only means of local transport -- Block kanchanpur

In order to illustrate further the location-specificity of arrangements, a case study of needs in Jampai hills as perceived by the local people, has been presented below

Jampai hills in the North Tripura district are part of the Mizo Hill Range largely inhabitated by the *Lushai* tribe who grow primarily orange orchards and tea plantations Unlike in the remaining part of the district, people are fairly literate here and they are even aware of renewable energy technologies More than 70% of the households have roof run-off tanks, improved *chulhas* and solar photovoltaic lighting systems

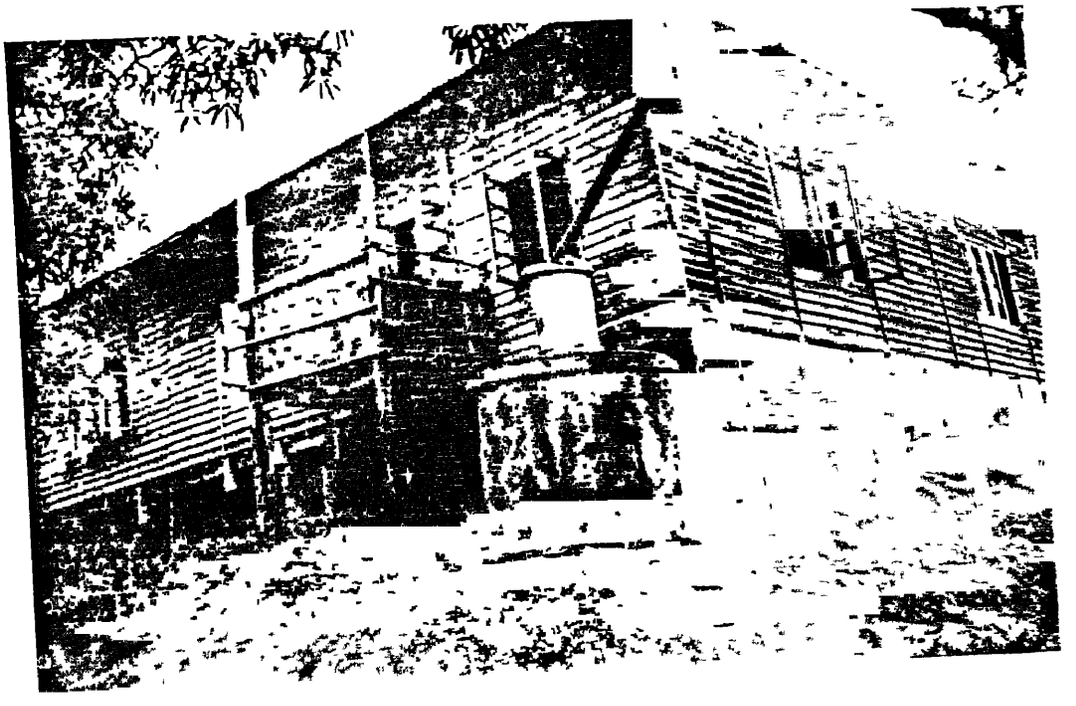
However, the supply of kerosene and LPG is grossly inadequate and people have to trudge long distances to acquire the fuels, some times as much as 35-40 km

Another major problem in the area is the drinking water as water sources dry up in winter and summer months (November to June) During this period almost 12 hours a day is spent by women in collecting water The roof run-off tanks constructed under the Technology Mission of the government did not solve the problem as the stored water did not last for more than a month whereas the scarcity existed for 5 to 7 months

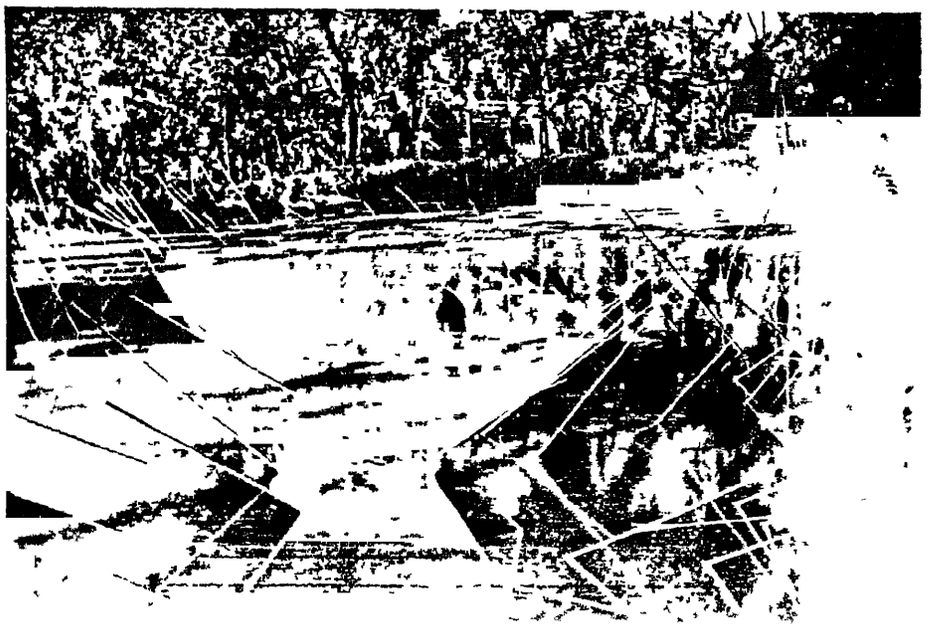
Thus supply of drinking water is the topmost priority articulated by the people who demand grid electricity to pump water But they were also prepared to go in for solar photovoltaics to solve their problem Likewise, they were willing to adopt improved *chulhas* but would like the supply of kerosene and LPG augmented It is clear that if energy programmes are to succeed here, they need to be linked with the problem of water scarcity

Significantly, energy requirements have not found a prominent place on the hierarchy of priorities anywhere in the district in the people's perceptions The major concern in this regard was strengthening of the public distribution system for fossil fuels, and providing electricity connections to the households, notwithstanding the fact that an overwhelming proportion of the energy requirements are met from fuelwood This again reflects a better availability and accessibility of biomass resource which is not severely stressed at present in the district A major implication of this situation is that whatever interventions are designed as part of the energy plan will, if they are to have a reasonable chance of success, have to be linked up with the general development priorities and income generation activities, instead of promoting these interventions as exclusively 'energy-saving' or 'environmentally sustainable' programmes For instance, fuelwood head-loading has become a subsistence activity for many poor tribal families but at the same time detrimental to the environment, so the proposed interventions should be able to limit this activity in order the safeguard the environment by providing viable alternatives to commercialisation of fuelwood

Roof runoff tank at Jumpai Hills constructed by Technology Mission



Bamboo for commercial purposes transported by river



Fish pond in Block Panisagar